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PIPE LINE INDUSTRY

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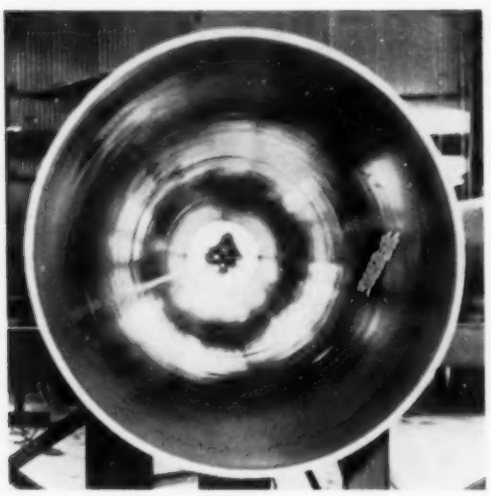

Tests Show How Internal Coatings Hike Thruput

Cleaning ten-year-old gas line increased capacity 4 percent; coating pipe internally, in-place, with epoxy coating boosted thruput up to 6 percent more page 36

AUTOMATIC CONTROL

Latest Features for Remote Systems 46

INTERNATIONAL CONSTRUCTION

Line Drops from Andes to Chilean Port 52

HIGHER STRENGTH PIPE

Research Tells More About Pipe Fatigue 58

For a "Quick Look" at this issue, turn the page . .

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The **Aircraft Equipment Division,** Greenwich, Conn., designs, produces and sells a wide range of controls for aircraft, missiles and nuclear applications.

The **Aerotherm Division,** Bantam, Conn., develops, fabricates and sells aircraft seating and accessories.

An expanded and intensified program is now underway to accelerate research, new developments and technical advances that will benefit you. If you have any problems or requirements in the above fields our engineers are ready to help solve them.

Write Aerotec Industries, Inc., Dept.-I, Greenwich, Conn.

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PIPE LINE INDUSTRY

CONTENTS and Quick Look

July, 1959 Vol. 11, No. 1

To help you put first things first, scan these time-saving digests, checking ☑ those you want to read first.

Don't Blow Up Your Pipe Line

An omission from the article "Mixing Crude with LPG, Distillates in Pipe Line" by A. N. Horne, PIPE LINE INDUSTRY, June 1959, Pages 68-71, could be serious.

The caption for Figure 2 should have read: "Normally valves 1, 2 and 3 are open. Valve 4 is closed. To bypass after scraper arrives, close valve 1 to be sure scraper passes through check valve; then open valve 1 and close valve 2. Open valve 4 and close valve 3. After scraper passes pig signal on the discharge side, **open valve 3,** close valve 4 and open valve 2. Then maintain normal operating positions."

Editor's Note: Failure to **open valve 3** could result in rupture of the line.

REGULAR MONTHLY DEPARTMENTS

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Flow Tests on Internally, In-Place Coated Pipe

☐ Perhaps the greatest advancement in natural gas pipelining in the past five years is the development of internal coatings that increase deliverability by smoothing the internal surface of the pipe. Results show an increase of 5 to 10 percent depending on the flow rate. But part of this increase can be attributed to internal cleaning. Still, many high-pressure transmission lines in the future will be internally coated as a result of these tests.

By C. H. Klohn ..... Page 36

How Fully Integrated Control Systems Work

☐ Fully integrated, remote controlled pipe line systems are here today, complete with a centralized computer and other automatic features. This is a rundown on how such systems work, what their limitations are and what to stress in designing such a system.

By William F. Haley ..... Page 46

Bolivian Line Extends Across Andes to Pacific Port

☐ One of the world's highest and steepest pipe lines, it plunges sharply from an elevation of 14,531 feet to sea level in about 80 miles. Over-all static head is 4,792, the world's highest. The line is a triumph in international relations. Bolivia is able to sell its excess crude via a Pacific seaport, thanks to an easement granted by Chile. The construction of the line was speedy despite the high derating factors occasioned by high altitudes.

By E. E. Mincheff ..... Page 52

More on Technical Advances in High Strength Pipe

☐ In January of this year, PIPE LINE INDUSTRY published an article by W. A. Saylor and A. B. Wilder on this subject. Additional information in this discussion bears out a number of the findings of Saylor and Wilder about fractures and test failures of pipe.

By H. H. George ..... Page 58

New Detector Guards Unattended Station from Combustible Hazards

☐ The device is quite simple: Air samples from the pump room are drawn into a combustion chamber along with a stream of propane. If the air sample contains no hydrocarbons, the mixture is too lean to ignite when the spark plug fires (24 times a minute). But a slight increase in hydrocarbons will cause an explosion thanks to the propane already in the mixture ..... Page 61

PIPE LINE INDUSTRY published every month. Entered as second class mail matter July 9, 1954, at the post office at Houston, Texas, under the act of March 3, 1879.

The second mile—and you

"Every calling has its mile of compulsion, its daily round of tasks and duties, its standard of honest craftsmanship, its code of man-to-man relations, which one must cover if he is to survive. Beyond that lies the mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance. It is only in this second mile that a calling may attain to the dignity and the distinction of a profession."

With these words Dr. W. E. Wickenden, president of Case Institute of Technology until his death, once defined before the Engineering Institute of Canada the extra endeavor by which men may excel. And he went back more than 1,900 years for his text, which was from the Sermon on the Mount—"Whosoever shall compel thee to go one mile—go with him twain."

To benefit from industry as an individual, one must assure himself that industry, in turn, is benefiting from him. It is a two-way thoroughfare.

How to do that calls for appraisal and improvement. And toward that end, help has been offered by the Professional and Training Committee of the Engineers Council for Professional Development. In a recent brochure, the ECPD supplied 40 questions concerning one's job, his profession, his personal development, and his general program of development.

One advantage of this self evaluation program is that it can be used by anyone, regardless of his job or position.

However, specifically designed for the field of engineering, the brochure contains eight questions which will materially assist in self evaluating one's own profession. This section of the brochure deals primarily with an individual's relation to his professional societies, his responsibility to them, and the advantages they offer him and his industry.

Since the professional society can offer great help in assisting an individual to cover the "second mile," these eight questions are listed below.

1. Am I a member of my professional society? Do I understand its aims?

2. What requirements for the next higher grade of membership in my professional society do I now fail to satisfy? What steps, beyond those already planned, should I take to correct my present deficiencies? When should I plan to attain full society membership? Are there other professional societies in whose activities I do or should participate?

3. What are my responsibilities to the other members of my profession? What service do they have a reasonable right to expect of me?

4. Am I taking advantage of the benefits offered to me through the professional societies by others of my profession?

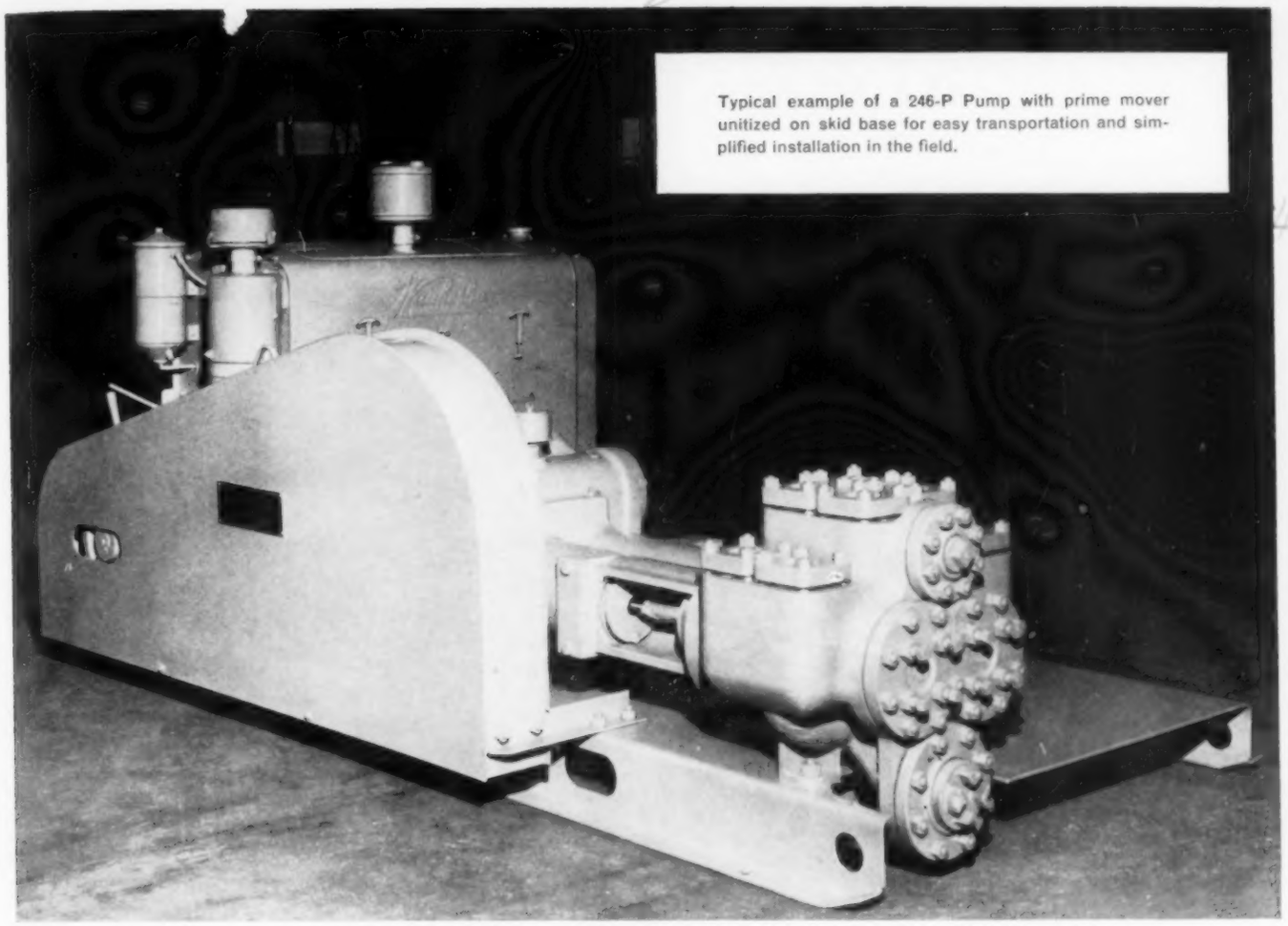
5. Is my program of reading adequate to keep me abreast of technological progress in fields which bear on the work of my career?

6. What have I done to familiarize myself with the performance standards of a professional engineer, and how have I applied these standards to my own work?

7. Does my position and do my ambitions make it desirable for me to be a registered professional engineer? If so, what further steps should I take toward qualifications: and when?

8. Am I a good representative of my profession in my community?

There is little doubt that many advancements in the oil industry owe considerable to the efforts of professional societies and to their aims. Therefore, frequent self appraisal of one's own value to the industry and the fuller understanding of what professional societies offer can only lead to a significant improvement in both the individual and industry.



Typical example of a 246-P Pump with prime mover unitized on skid base for easy transportation and simplified installation in the field.

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Piston Size Range Inches	Rated Working Pressure (psi)	Barrels per 24 Hours at Pump Speeds (rpm) of:			
		40	60	80	100
2½	900	651	960	1,269	1,612
3	600	942	1,415	1,885	2,360
3½	450	1,310	1,965	2,620	3,275
4	350	1,730	2,590	3,455	4,320
Brake Horsepower Required		11.5	17.1	22.9	28.5

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Indexed by Engineering Index

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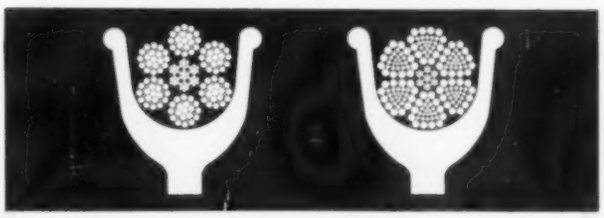

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Compare Yellow Strand Flattened Strand (right) with round strand wire rope (left). Note how Flattened Strand gives 12 points of contact with sheave groove, with consequent greater bearing area and smoother surface. This results in longer service life for rope, sheaves and drum.

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Wire Rope

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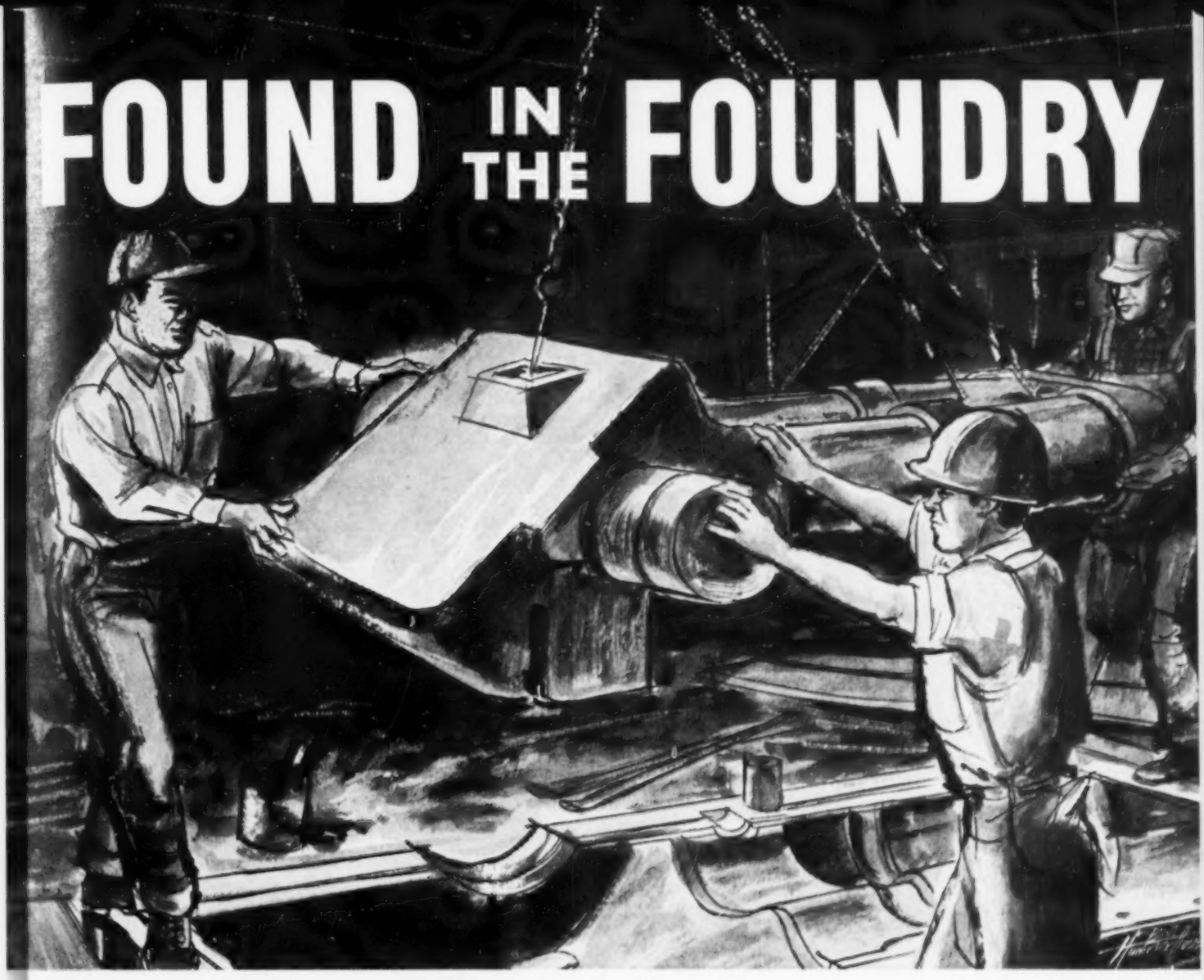

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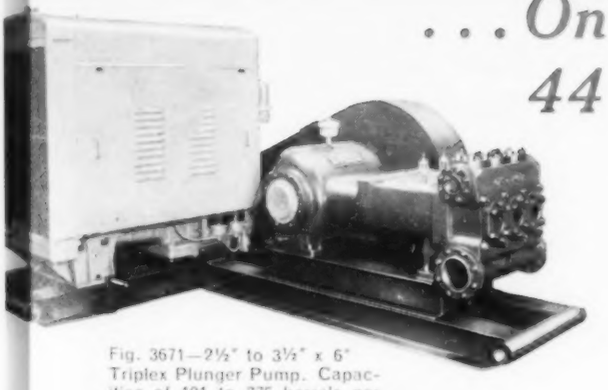

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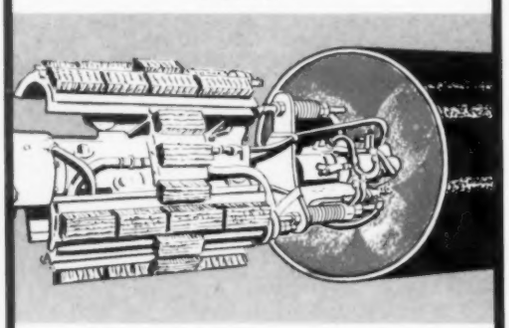
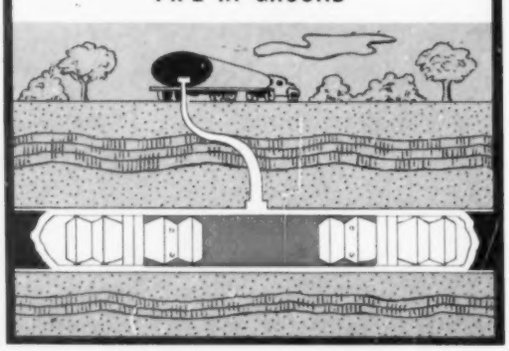


PIPE IN GROUND



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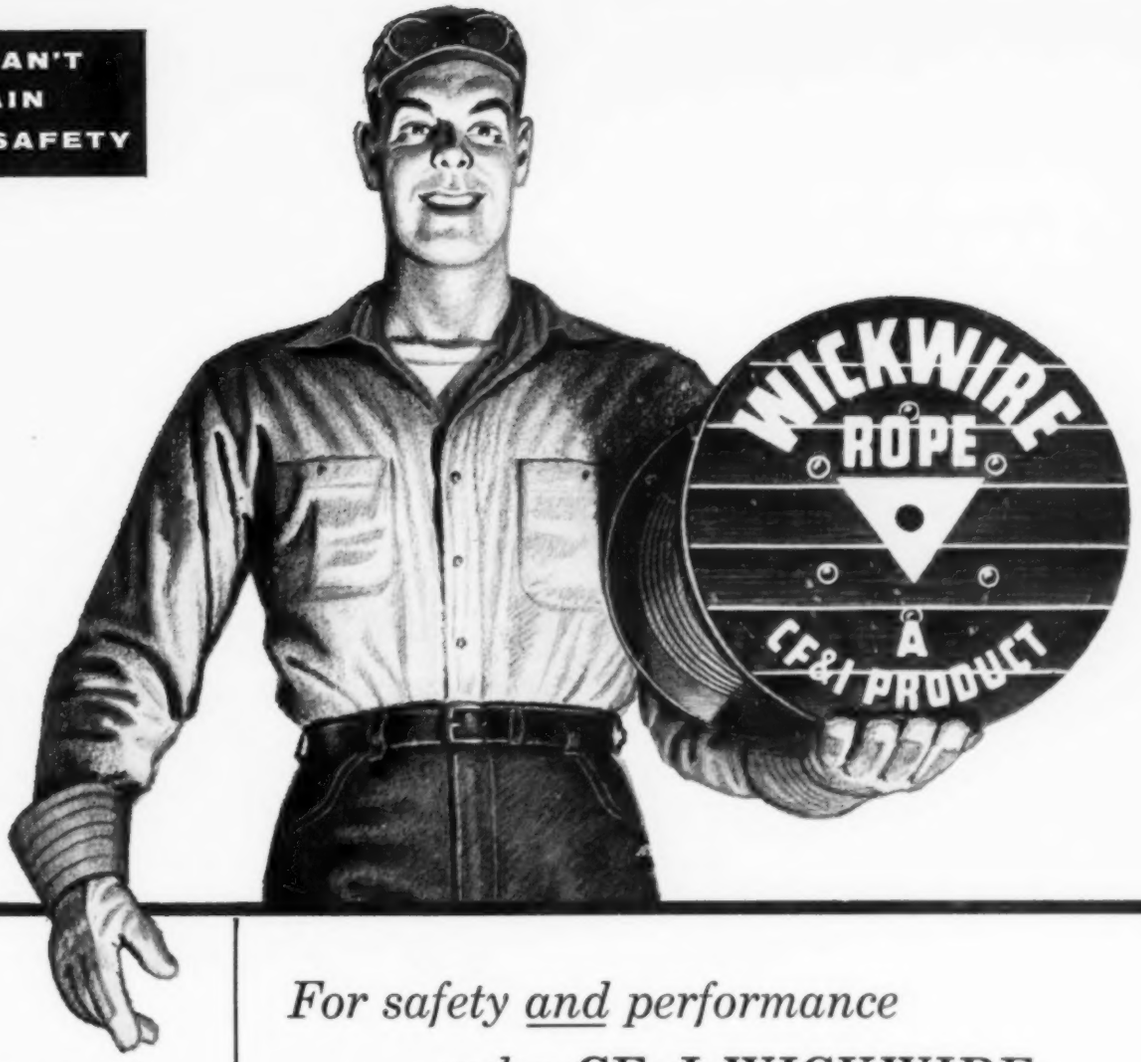

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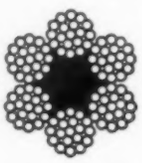
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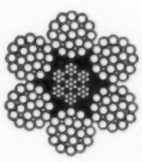

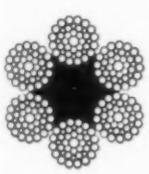
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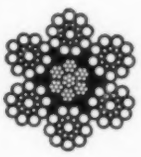

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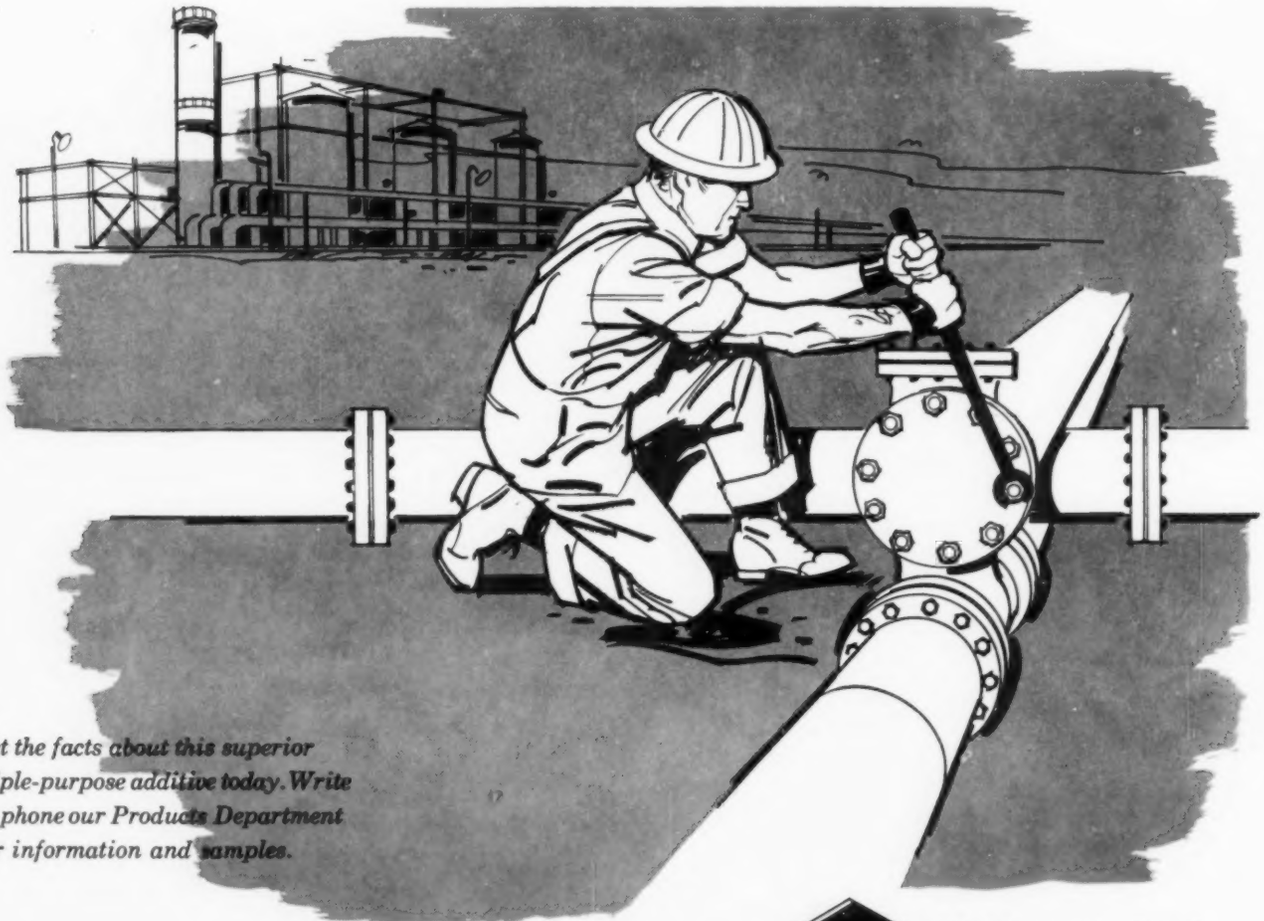

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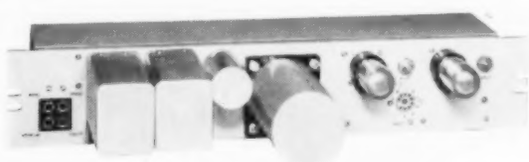
Reliability: quality components, with safety ratings well above accepted norms, assure long life while reducing maintenance and replacement costs to a bare minimum.

Appliques: also available are various types of adaptors for: Dial Station, Dial Trunk, Teletype or V.H.F. Transmitters; Selective Ringing Units; Line and Station Adaptors; and 4-wire Switching Equipment.



STROMBERG-CARLSON TONE UNITS

. . . fill your growing need for amplitude-modulated tone transmitting and receiving equipment in telegraphy, telemetering and control on wire line, carrier and radio circuits.

Delivery on multiplex and tone signaling equipment is prompt; service is available from our field engineering staff. Write for descriptive literature.

S-C | GD

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

TELECOMMUNICATION INDUSTRIAL SALES

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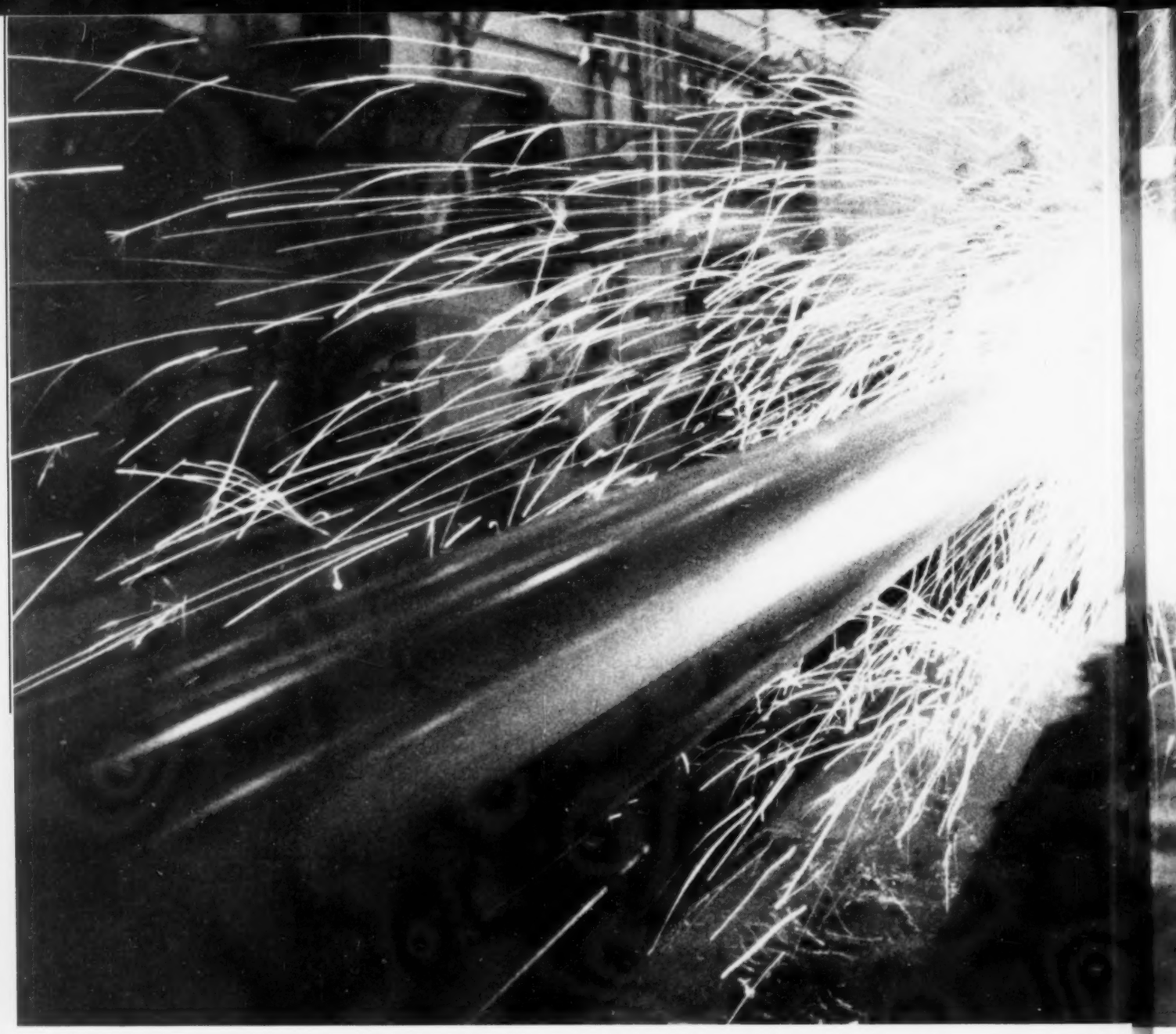
For more data on advertised products, use Readers' Service Cards, last page.



TEX-TUBE Teamwork

Walk through Tex-Tube's modern pipe mill in Houston and you'll see teamwork in action. You'll witness the painstaking care that goes into manufacturing the world's finest lightwall pipe; the quality control—from selection of skelp to electric resistance welding to hydrostatic testing to final inspection.

Tex-Tube Lightwall Pipe and other quality products are stocked at six strategic locations for fast delivery to your jobsite. Close teamwork between Tex-Tube's mill, sales-service and distribution facilities means a dependable supply of these quality tubular goods available to you at all times. Count on Tex-Tube.

rk helps you

TEX-TUBE, INC.

503 NORTH POST OAK ROAD • HOUSTON, TEXAS

Sales Offices in Midland, Texas—Tulsa, Oklahoma—
Dallas, Texas—Los Angeles, California

ALLIED CHEMICAL'S HOTLINE ENAMEL SOLVES HOT-SIDE PROBLEMS

Allied Chemical's Hotline Enamel takes high temperature punishment from the hot-side of compressor stations . . . for years! Allied Chemical's Hotline Enamel won't crack at −10°F.—as proved in laboratory tests and on-the-job performance for leading public utility companies.

Allied Chemical's *Job-Matched* Hotline Enamel is derived from coal-tar pitch, thus possessing inherent protective properties against the damaging effects of water, soil chemicals and electrical currents. In addition to these properties, Hotline Enamel is bargain rated both for initial cost and long-run service.

Provides improved protection under all these specific conditions:

1. Hot gas pipelines, on discharge side of compressor stations where line temperature is above 120°F.
2. On pipe-type cables or "oil-o-static lines" which are subject to internal electrical heat from high-voltage surges.
3. Warm, swampy areas or other places where excessive soil stress on pipelines is encountered.
4. Areas where backfill and trenches are rough, rocky or contain foreign objects which normally penetrate softer coatings.
5. Pipelines (such as heated fuel lines) where temperatures are consistently high most of the time. but do not exceed 180°F. or for short-term exposure, 200°F.

A staff of Field Service Experts are at your call to offer you technical assistance that can save you maintenance time and costs.

PLASTICS AND COAL CHEMICALS DIVISION
40 Rector Street, New York 6, N. Y.

Allied Chemical

The failure-proof plant

Nothing is really failure-proof. But the best technicians know that failures in metal parts are held to the minimum whenever *Ansco* X-ray films are on the job.

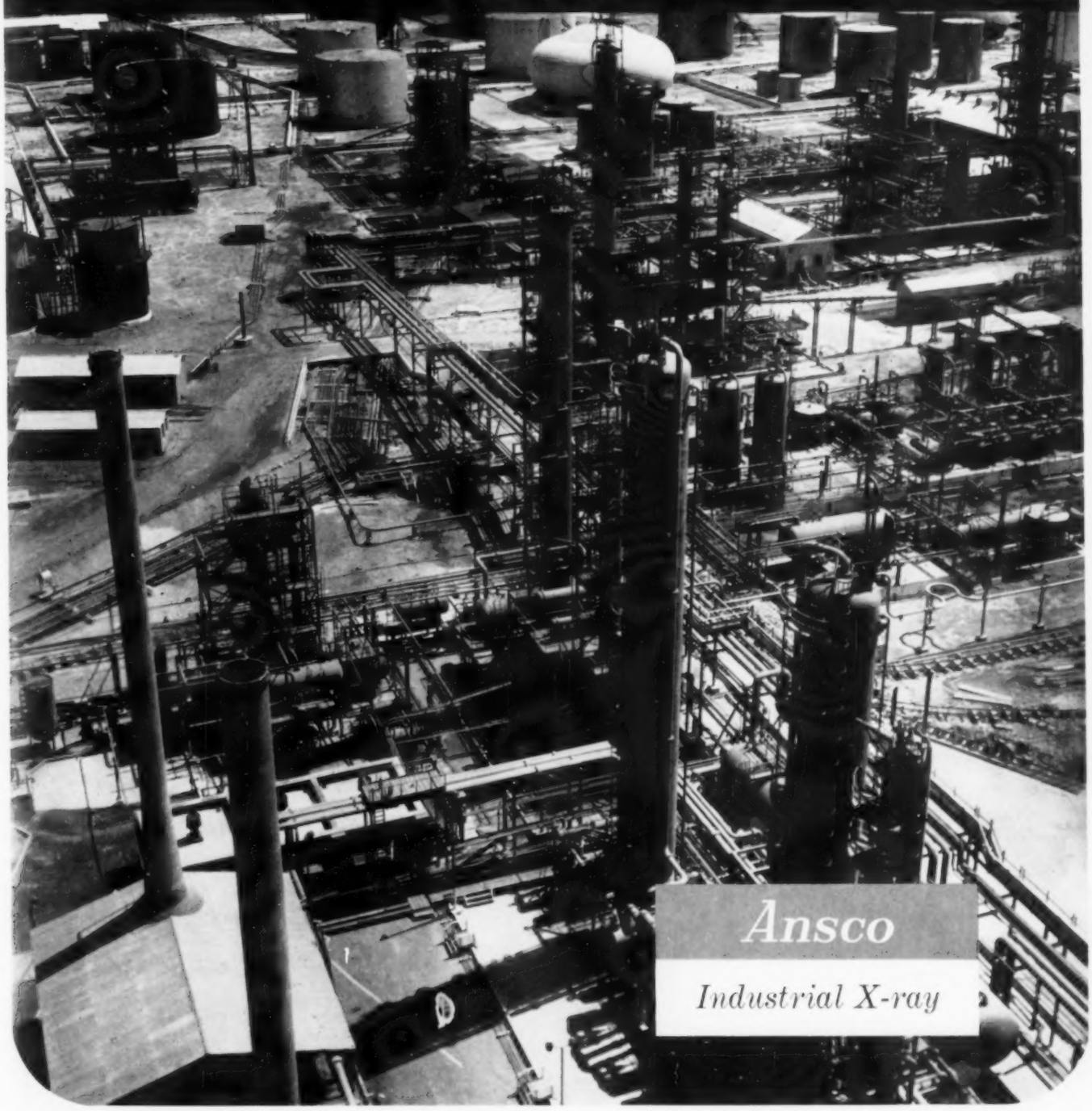
Ansco industrial X-ray films are specifically designed to aid in detection of even the most elusive flaws. And the images recorded are clear and clean with maximum separation of densities. This means quick, easy readability.

Three great films; *ANSCO SUPERAY 'A,' 'B'* and *'C'* cover every need regardless of the type of equipment or specimen involved.

ANSCO SUPERAY 'A' for most general applications with high or low KVP.

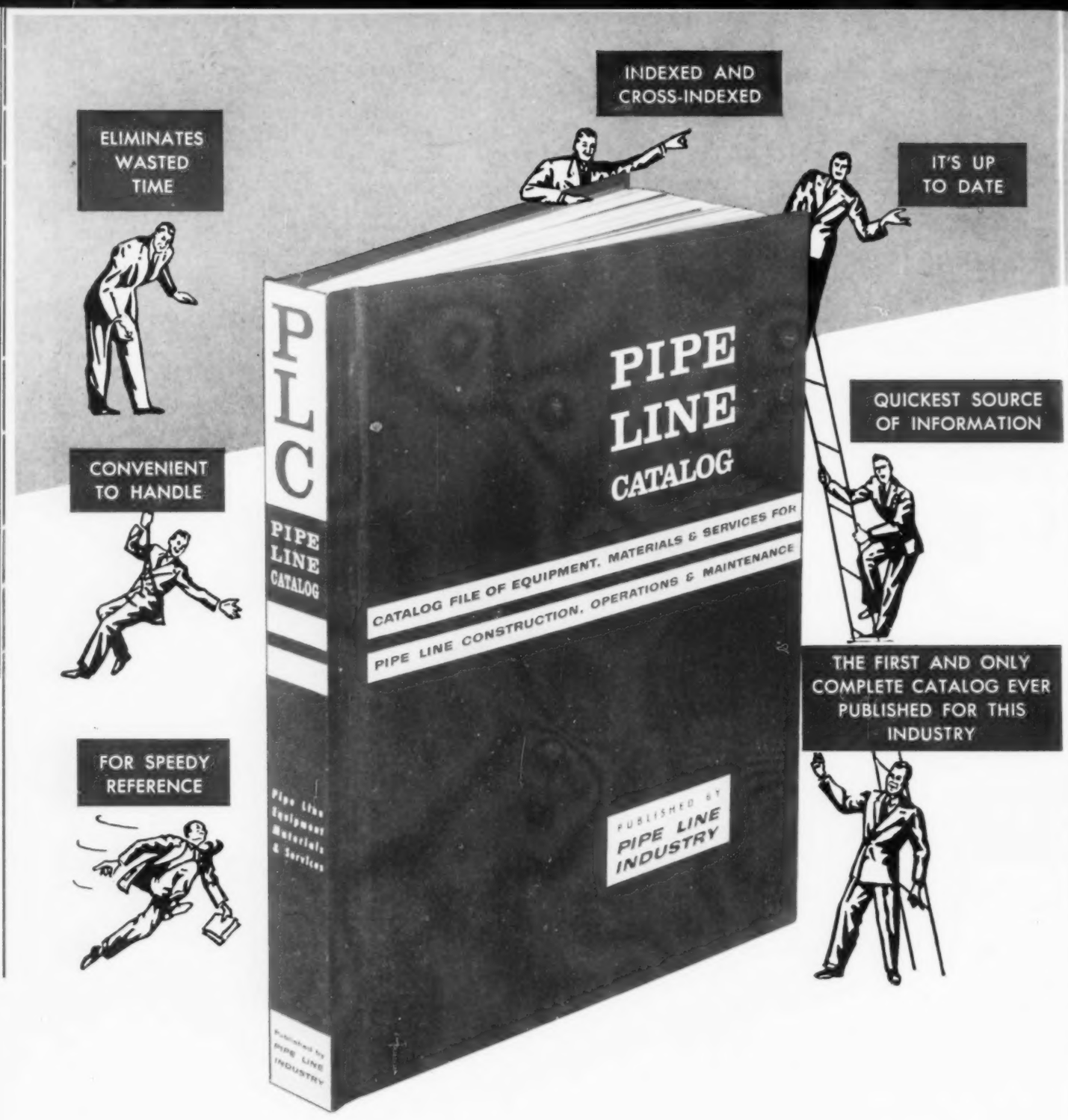
SUPERAY 'B' for critical reading especially at high KVP.

ANSCO SUPERAY 'C' for high speed production line applications. Try these fine Ansco films soon . . . and your plant will be as close to failure-proof as it is imaginable. Ansco, Binghamton, N. Y., A Division of General Aniline & Film Corporation.



Ansco

Industrial X-ray


INDEXED AND CROSS-INDEXED
ELIMINATES WASTED TIME
IT'S UP TO DATE
QUICKEST SOURCE OF INFORMATION
CONVENIENT TO HANDLE
THE FIRST AND ONLY COMPLETE CATALOG EVER PUBLISHED FOR THIS INDUSTRY
FOR SPEEDY REFERENCE
PLC
PIPE LINE CATALOG
PIPE LINE CATALOG
CATALOG FILE OF EQUIPMENT, MATERIALS & SERVICES FOR
PIPE LINE CONSTRUCTION, OPERATIONS & MAINTENANCE
PUBLISHED BY
PIPE LINE INDUSTRY

The only catalog data file being published especially for the Pipe Line Business is a real success. It is serving as a genuine time saver for operating and field executives, superintendents, foremen, engineers, purchasing agents and many others who buy or specify equipment and materials.

More than 165 leading companies have filed their complete or condensed catalogs in this useful volume. Compiled by the manufacturers themselves, this information is arranged and indexed to offer a quick and convenient means of locating *what you want when you want it.*

If furnished to you in individual brochures, bulletins or specification sheets, the information that is now condensed into this composite catalog file would fill the equivalent of several file drawers or book shelves.

On the opposite page you'll find a complete list of the companies that have filed data in the specialized Pipe Line Catalog. When you are looking for sales information, be sure to check these companies in your Pipe Line Catalog. It is the most complete source of buying information available in one volume for this industry today.

CF Industries, Inc., W-K-M Div.
erotec Corp.
itken, M. N. Company
drich Pump Co.
lied Chemical, Plastics & Coal Chemical Division
llis-Chalmers Mfg. Co.
ston Mfg. Co.
merican Blower Division American-Standard
merican Cable Div. American Chain & Cable Co., Inc.
merican Chain & Cable Co., Inc. R-P & C Valve Div.
merican Cyanamid Co. Jefferson Chemical Co. Inc. Subsidiary
American-Marietta Co.
American-Standard, American Blower Division Norwood Controls Unit Detroit Controls
Anchor-Wate
Anderson, V. D. Co.
Andrews Tower, Inc.
Automatic Power Inc.

Barber-Greene
Beaird J. B. Co. Inc.
Bethlehem Steel Co. Supply Div.
Bettis Corp.
Bonney Forge & Tool Works
Borg-Warner Corp., Byron Jackson Div.
Bucyrus-Erie Co.
Buffalo-Eclipse Corp., Penberthy Mfg. Co. Div.
Byron Jackson Pumps Inc. Subsidiary of Borg-Warner Corp.

Carver-Stimpson Pipe Cleaning Co. Inc.
Caterpillar Tractor Co.
Cathodic Protection Service
Central Plastics Distributing Co.
Centrifix Corp.
Challenge Mfg. Co.
Chance, A. B. Co.
Charles Machine Works, Inc.
Chemetron Corp., Tube Turns Division
Cherokee Laboratories, Inc.
Clark Bros. Co., One of The Dresser Industries
Coffing Hoist Div., Duff-Norton Co.
Colorado Fuel & Iron Corp. Wickwire Spencer Steel Div.
Commercial Iron Works
Cooper-Bessemer Corp.
Corrosion Services Incorporated
Corrosion Rectifying Co., Inc.
Cotten, G. A. Co.
Crane Co.
Crose, M. J. Mfg. Co. Inc.
Crutcher, Rolfs, Cummings, Inc.

Darling Valve & Mfg. Co.
Day, S. D. Co.
Dresser Industries, Clark Bros. Co. Div. Magnet Cove Barium Corp. Div.
Duff-Norton Co., Coffing Hoist Div.
Dunlap Mfg. Co.
Duriron Co. Inc.
Dutch Brand Div., Johns-Manville Corp.

Edison, Thomas A. Industries, Instrument Division
Allan Edwards, Inc.
Elliott Co., Ridgway Division
Elsey Mfg. Co.
Ensign-Bickford Co.

Falk Corp.
Farrel-Birmingham Co., Inc.
Flexitallic Gasket Co.
Fluor Products Co.
Fram Corp., Warner Lewis Co. Div.

These leading manufacturers, suppliers and service companies have filed complete or condensed catalog data in the current edition of the new PIPE LINE CATALOG. See their detailed information in the catalog when you are ready to buy.

Gardner-Denver Co.
Garrett Oil Tools, Inc., Division of U. S. Industries, Inc.
Gaso Pump & Burner Mfg. Co.
Gasoline Plant Construction Corp.
Gearench Mfg. Co.
General Descaling Co., Ltd.
General Electric Co., Apparatus Division
Gorman-Rupp Co.
Greenhead Sling & Supply Co.
Greenwood Valve Division Vernon Tool Co., Ltd.
Grove Valve & Regulator Co.

H & M Pipe Beveling Machine Co.
Hamer Valves, Inc.
Hercules Motors Corp.
Homelite, Division of Textron Inc.
Horton Equipment Co.
Hudson Engineering Corp.
Humble Oil & Refining Co.
Hydril Co.

Indus Corp.
Ingersoll-Rand
Instruments, Inc.

Jefferson Chemical Co., Subsidiary of American Cyanamid Co.
Johns-Manville Corp., Dutch Brand Div.

Kellogg, Communications Division of ITT
Kinzbach Tool Co., Inc.
Knudsen, Vic Co.

L & M Company
Ladish Company
Ledeen Mfg. Co.
Leland Equipment Co.
Lewis, Warner Co. Div. of Fram Corp.
Lloyd Metal Foundry

Magnet Cove Barium Corp. One of The Dresser Industries
Magnetrol, Inc.
Mallay Tool Service
Maloney, F. H. Co.
MAREP, S. N.
Marsh Instrument Co.
Mason-Neilan Div. of Worthington Corp.
Mathey, C. A. Machine Works, Inc.
Mavor-Kelly Company
McCord Corp.
McFarland Engineering & Pump Co.
McFarland Mfg. Corp.
McKissick Products Corp.
Mercoid Corp.
Midwestern Manufacturing Co.
Midwestern Pipe Line Products Co.
Mine Safety Appliances Co.
Mixing Equipment Co., Inc.
Morris-Young-Owens Co.
Murphy, Frank W. Mfr. Inc.

National Tank Co.
Naylor Pipe Co.
Nickles Machine Corp.
Norwood Controls Unit, Detroit Controls Division of American-Standard

Oil Well Supply Div. of U. S. Steel

Peerless Mfg. Co.
Pelican Supply Co., Inc.
Penberthy Mfg. Co., Division of Buffalo-Eclipse Corp.
Perrault Equipment Co.
Petrolite Corp., Tretolite Co. Div.
Philco Corp., Government & Indus. Div.
Philip Carey Mfg. Co.
Pipe Line Development Co.
Pittsburgh-Des Moines Steel Co.
Plastics & Coal Chemicals Division of Allied Chemical
Portable Bridge & Equipment Co.
Pottermeter Co., Division of Potter Aeronautical Corp.
Protecto Wrap Co.

Quality March Equipment Co., Inc.

R-P & C Valve Div., American Chain & Cable
Ramsey Winch Mfg. Co.
Ray-Test Engineers, Inc.
Reilly Tar & Chemical Corp.
Remco Manufacturing Co.
Ridgway Div., Elliott Co.
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Riggs, Wm. L. Co.
Robishaw Engineering Inc.
Rochester Manufacturing Co., Inc.
Rolo Manufacturing Co.
Ruberoid Co.

Shafer Valve Co.
Skinner, M. B. Co.
Sooner Boomer Mfg. Div.
Southern Mill & Mfg. Co.
Sprague Engineering Corp.
Standard Magnesium Corp.
Staytite Co.
Stearns, D. E. Co.
Stearns, N. C. Co.
Steel Forgings, Inc.
Stewarts & Lloyds Ltd.
Superior Equipment Co.
Sewco, Inc.

Textron, Inc., Homelite Division
Thermix Corp.
Thornhill-Craver Co., Inc.
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Tretolite Co. Div. of Petrolite Corp.
Tube Turns Div. of Chemetron Corp.

Union Switch & Signal Div. of Westinghouse Air Brake Co.
U. S. Industries, Inc., Garrett Oil Tools, Inc. Division
United States Motors Corp.
United States Steel Corp., Oil Well Supply Division
Universal Oil Products Co.

Vereinigte Armaturen-Gessellschaft MBH
Vernon Tool Co., Ltd. Greenwood Valve Division
Voss, J. H. H. Co., Inc.

W-K-M Div. of ACF Industries, Inc.
Wachs, E. H. Co.
Waldron, John Corp.
Waukesha Motor Co.
Westinghouse Air Brake Co., Union Switch & Signal Division
White Diesel Engine Division The White Motor Co.
Whitmore Homebuilders, Inc.
Wickwire Spencer Steel Division The Colorado Fuel & Iron Corp.
Wilkinson Products Co.
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Worthington Corp., Mason-Neilan Division

Yale Machine Works

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PIPE LINE CATALOG

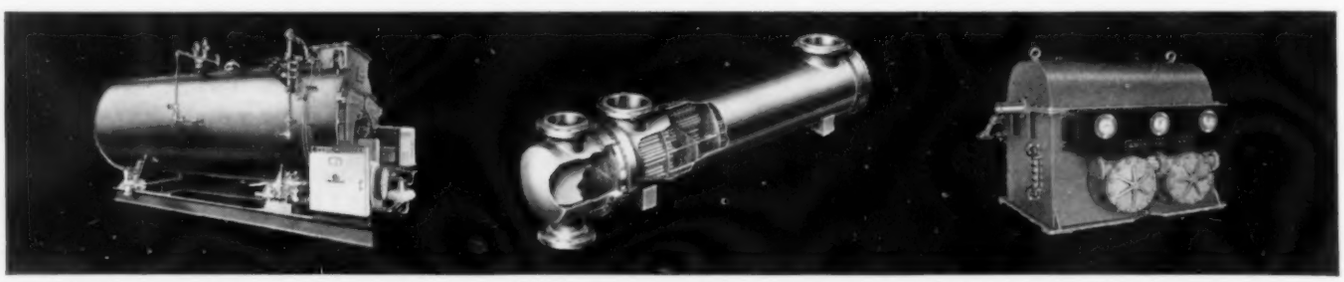
P. O. BOX 2608 *Published by PIPE LINE INDUSTRY* **HOUSTON, TEXAS**

Evaluating equipment for your pipeline stations?

Be sure one of the sources you consider is AMERICAN-Standard Industrial Division

HERE'S WHY: By combining the engineering backgrounds and product lines of three American-Standard* divisions – American Blower, Ross Heat Exchanger, and Kewanee Boiler – the new Industrial Division offers one-source responsibility for quality and performance in equipment that is designed, engineered, and manufactured to work together.

There are engineer-staffed offices in all principal cities to work with architects, consulting engineers, and contractors with equipment selection and on-the-job problems. Contact the one nearest you. American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Limited, Toronto, Ontario.



Firebox, scotch-type steel boilers and package units for heat, power, steam.

Heat exchangers, condensers, and feed-water heaters for every requirement.

Fluid drives for adjustable-speed control of pumps and fin-fan coolers.

*AMERICAN-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation.

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INDUSTRIAL DIVISION

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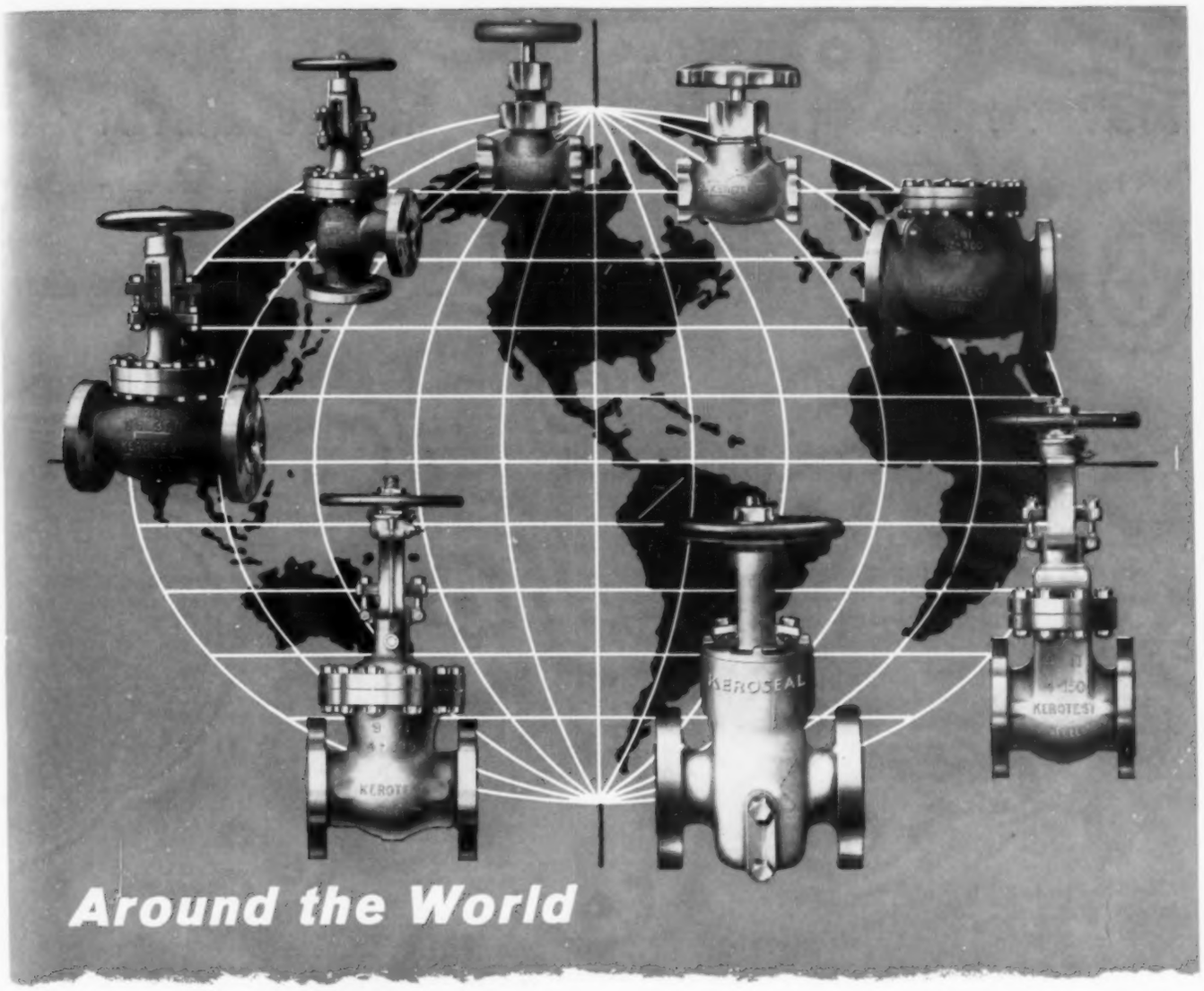


Around the World

. . . and 50 Years of quality VALVES

Visit oil and gas industries, processing and other industrial plants in any country in the world and you will find Kerotest Valves at work in a multitude of jobs. This universal acceptance of Kerotest Valves is the result of a continuous effort toward product improvement ever since the company was founded in 1909.

Around the world and 50 years later, Kerotest still continues to make highest quality valves, with consistent effort toward even greater product improvement. Each step in Kerotest Valve manufacture, from raw materials to final rigid inspection, is the result of research and engineering directed solely to obtaining better product performance on the job. The results of these efforts have set Kerotest Valves apart from the ordinary and have maintained their high standards of quality everywhere.

For additional information on valves for your requirements, write today for the latest Kerotest brochure.

KEROTEST QUALITY VALVES FOR EVERY REQUIREMENT

- Gate Valves
- Globe Valves
- Angle Valves
- Check Valves
- Pipe Line Valves
- Positive Shut-Off Valves
- Production Valves
- Needle Valves
- Well Head Equipment
- General Purpose Valves
- Special Valves

KEROTEST MANUFACTURING COMPANY

2512 LIBERTY AVENUE • PITTSBURGH 22, PA.

In Canada, Kerotest products are manufactured and distributed exclusively by Guelph Engineering Company, Guelph, Ontario.

KEROTEST

Now . . . for the first time in the history of

GUARANTEED

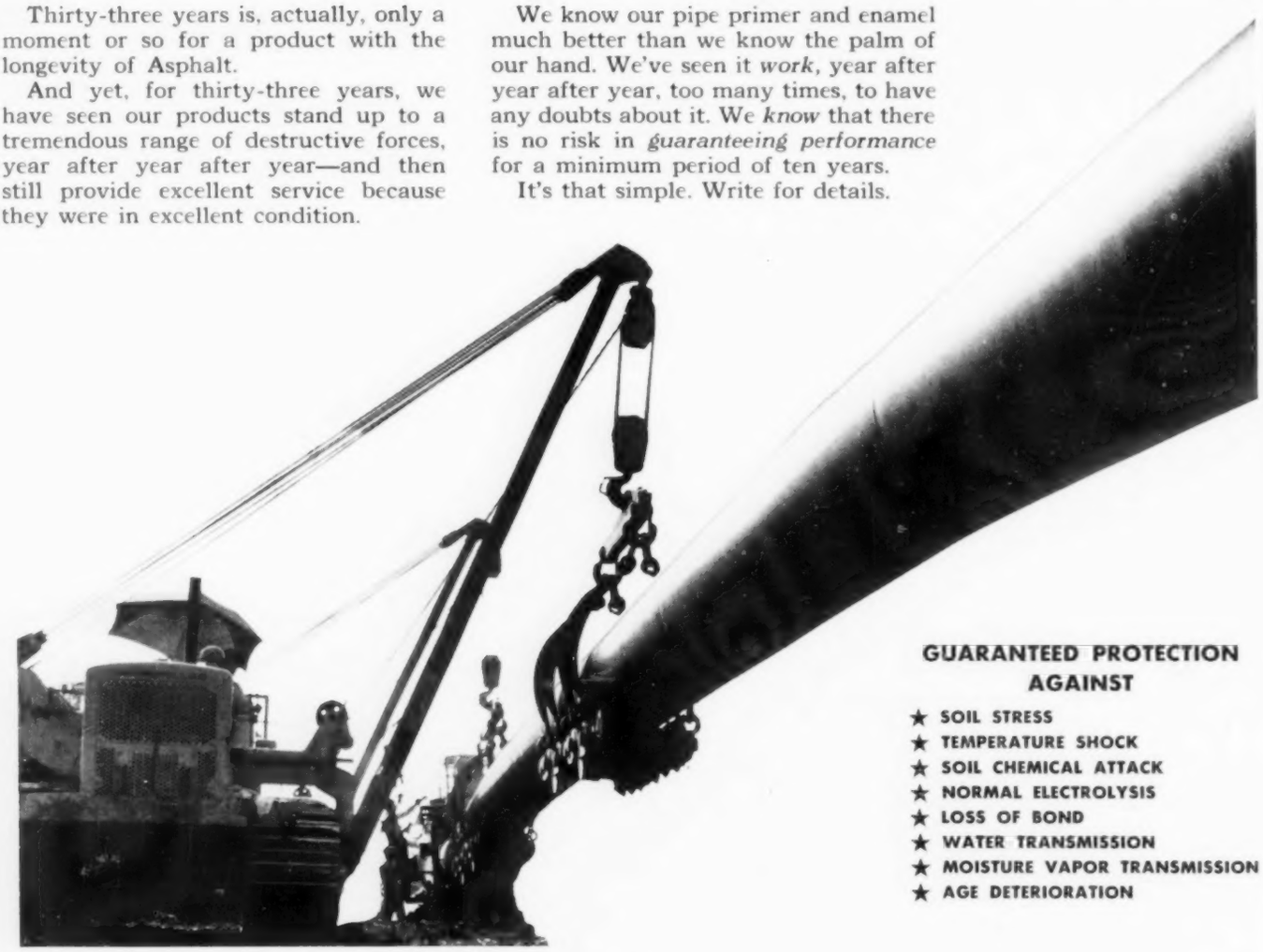
OF PIPE PRIMER

Thirty-three years is, actually, only a moment or so for a product with the longevity of Asphalt.

And yet, for thirty-three years, we have seen our products stand up to a tremendous range of destructive forces, year after year after year—and then still provide excellent service because they were in excellent condition.

We know our pipe primer and enamel much better than we know the palm of our hand. We've seen it *work*, year after year after year, too many times, to have any doubts about it. We *know* that there is no risk in *guaranteeing performance* for a minimum period of ten years.

It's that simple. Write for details.



GUARANTEED PROTECTION AGAINST

- ★ SOIL STRESS
- ★ TEMPERATURE SHOCK
- ★ SOIL CHEMICAL ATTACK
- ★ NORMAL ELECTROLYSIS
- ★ LOSS OF BOND
- ★ WATER TRANSMISSION
- ★ MOISTURE VAPOR TRANSMISSION
- ★ AGE DETERIORATION

GULF STATES Asphalt COMPANY

DIVISION OF BRAMBLE INDUSTRIES

BI

NATIONAL SALES OFFICES: MELROSE BUILDING • CApitol 4-2507 • HOUSTON 2, TEXAS

the industry . . . a manufacturer dares to offer

PERFORMANCE AND ENAMEL

READ THE HIGHLIGHTS OF THIS

PRECEDENT—SHATTERING GUARANTEE!

Question: What is your basic guarantee?

We guarantee that when our two products, Gulf States Pipe Primer # 474 and Gulf States Pipe Enamel # 434, are applied in accordance with our printed instructions and good pipeline practice, these materials will provide adequate and proper pipe protection for a minimum period of ten years. Experience indicates that when the enamel is in good condition at the expiration of the ten year guarantee period, the effective life of the enamel is indefinite.

Question: Specifically, what do you guarantee against?

Our guarantee covers:
Soil Stress.....Cracking, Wrinkling, Puckering
Loss of Bond.....Moisture Vapor Transmission
Cold Flow.....Age Deterioration
Temperature Shock.....Normal Electrolysis
Water Transmission.....Soil Chemical Attack
Bacteria.....Insects.....Fungus.....Vegetable
Roots.....Burrowing Animals.

Question: What further performance guarantees do you make?

We guarantee to check enamel resistance at the time of line completion, and guarantee that the initial current requirements necessary to obtain a pipe to soil potential of 0.85 volts as measured with a saturated copper copper sulfate electrode shall not exceed one ampere per mile of pipe, if the application has been properly made and under good pipeline standards.

We further guarantee that when the backfill has consolidated for one year, the current requirements per mile of pipe will not exceed by more than 10% the initial current values required to give a minimum pipe to soil potential of 0.85 volts.

We further guarantee to check the line periodically until the expiration of the ten year guarantee.

Question: What kinds of lines are included?

This guarantee has been developed for transmission and products lines plus required gathering lines. Specifically excluded are lines in metropolitan areas and municipal distribution lines.

Question: What are the conditions of the guarantee?

The following conditions are obviously necessary and are required by both common sense and fair play:

a. Proper application and procedures as set forth by N.A.C.E. or equivalent.

b. Good pipeline practice in application and subsequent handling. Use of rock shield and padding when needed.

c. Proper protective steps as defined by N.A.C.E.

d. Proper and adequate cathodic protection as defined. Appropriate leads shall be placed on the line when installed in order to permit full and complete electrical resistance inspection.

e. All bare lines or other contacts with metal are to be isolated by electrical insulation.

f. Mechanical damage or exposure to foreign contacts, line taps, leak repairs, and/or Acts of God cannot be included. By Acts of God we mean such forces as earthquakes, floods, bombing, lightning and other acts completely beyond the control of the builders or the guarantors.

g. Our engineers are to be permitted to review original specifications and to make an inspection of the right of way. Service representatives are to be given full cooperation by the contractor during application and other work prior to final backfill. When indicated, suggestions will be made to the end that the best possible job be realized.

Question: Does the application of this guarantee require that we depart from our customary procedures?

Not at all. We simply guarantee the performance of Gulf-States Pipe Enamel #434 and Gulf-States Pipe Primer #474 for the full protection of your pipeline under normal circumstances for a minimum period of ten years.

Question: What inspections do you contemplate making?

With your permission, periodic inspections will be made at which time any authorized inspector of the operator's or owners will be welcome. We would use either our equipment or the customer's, providing it is of a type capable of yielding the precise data we need. The line will be checked periodically until the expiration of the ten year guarantee.

Question: How is a complaint handled?

Engineers from the buyer and seller make an immediate inspection. The cause of failure is ascertained, responsibility assigned and the matter handled between them. Should these representatives be unable to arrive at a mutually agreeable decision, we agree to the appointment of an arbitration board consisting of one individual from each of the two parties, and these two representatives to appoint a third arbiter agreeable to both parties. This third person must be a reputable, recognized corrosion engineer capable of passing judgment on situations of this type. The decision of this board is final. Any costs involved in the examinations and determination of responsibility are to be borne by the participant found at fault.

Question: What is your responsibility?

If corrosion has occurred as a result of product failure, Gulf States Asphalt Company will, at its option, supply such additional cathodic protection as is required or will replace such defective enamel. It would seem highly unlikely that significant metal damage could occur between inspections; should this happen, however, Gulf State Asphalt Company will, at its option, supply such additional cathodic protection as is required, or will replace the defective metal.

WRITE FOR COMPLETE DETAILS

GULF STATES ASPHALT COMPANY
Melrose Building • Houston 2, Texas

Please provide us with complete details on your pipe enamel and primer guarantee.

Name.....Title.....
Organization.....
Street Address.....
City & State.....

FACTORIES: SOUTH HOUSTON • BEAUMONT • DENVER

For more data on advertised products, use Readers' Service Cards, last page.

So many ways the *FISHER/MAN*
can give you a helping hand with the

WIZARD II
PRESSURE CONTROLLERS

- Two Position Controller
- Proportional Controller
- Proportional Controller —Remote Set
- Differential Proportional Controller
- Pressure Transmitter
- Differential Proportional Controller— Remote Set
- Proportional Reset Controller
- Differential Proportional Reset

This "Jack of ALL Trades" is surprisingly low in cost

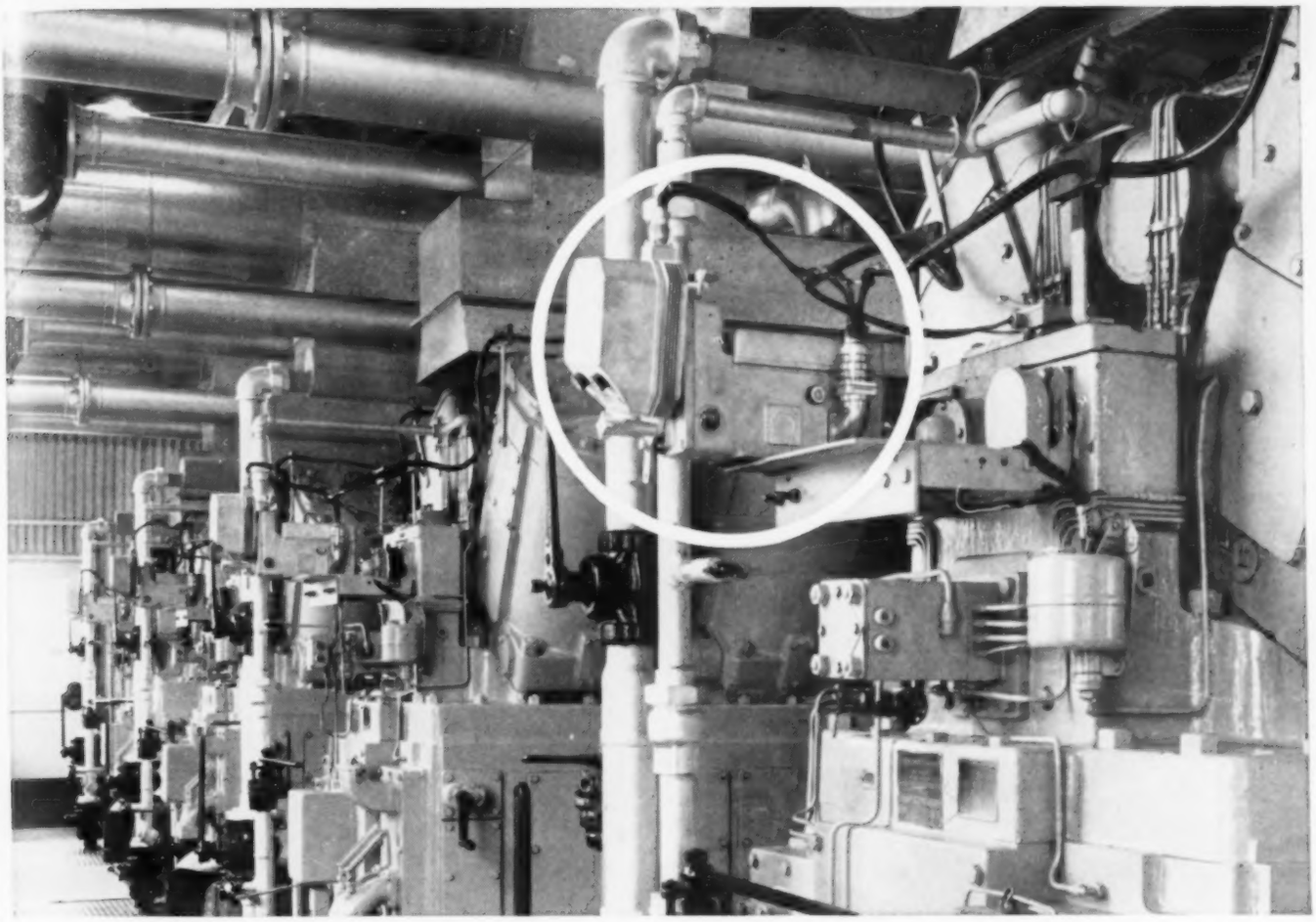
The partial list of applications at left tells you why the Wizard II is so aptly named. Probably no other controller in the Fisher line is as versatile. Available in brass, steel or stainless steel Bourdon tubes for ranges from 25 to 10,000 psi. Brass or stainless steel bellows available for low pressure service from 30" Hg Vacuum to 30 psi.

Fisher has carefully designed each component of the new Wizard to satisfy the most rigid process control requirements. A completely descriptive and illustrated booklet on the Wizard II is yours for the asking. Write for Bulletin D 4150 A.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

FISHER GOVERNOR COMPANY
Marshalltown, Iowa / Woodstock, Ontario / London, England
CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

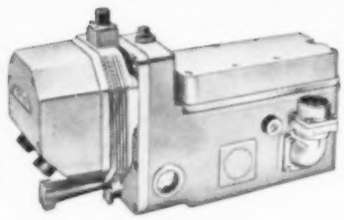
FISHER® Controls
SINCE 1880



BENDIX DLC IGNITION

designed specifically for natural gas and petroleum industries

Hi-V Coil



DLC Magneto

A MATCHED IGNITION SYSTEM

1. Long service life
2. Simplified maintenance
3. Longer spark plug life
4. No unscheduled ignition shutdowns
5. Positive spark timing
6. High voltage output
7. Matched ignition system
8. Single or dual ignition
9. Flameproof
10. Low maintenance costs
11. For engines of 6 through 16 cylinders

At the installation shown here, DLC Ignition unfalteringly performs its function in aiding with the preparation of natural gas for consumer use.

Bendix* DLC Ignition is the result of the most modern engineering design, and incorporates the latest developments in ignition materials. That's why it meets the most exacting requirements of modern high-compression engines used by the natural gas and petroleum industries.

Because DLC Magneto and Hi-V Transformer Coils form a matched ignition system, it delivers ample voltage while, at the same time, assuring reduced maintenance costs.

If you want facts on why important operators specify Bendix DLC Ignition, write: SCINTILLA DIVISION, BENDIX AVIATION CORPORATION, SIDNEY, NEW YORK. *REG. U.S. PAT. OFF.

Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. *Canadian Affiliate:* Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. *Factory Branch Offices:* Burbank, Calif.; Orlando, Florida; Chicago, Ill.; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.

Scintilla Division
SIDNEY, N. Y.

Bendix
AVIATION CORPORATION

For automatic control of unattended pumping stations PNEUMATIC CONTROL IS BEST!

It's best for several good reasons:

1. Initial investment is lower than that for other forms of control.

2. Maintenance costs are reduced, since no auxiliary equipment is necessary to determine engine speed. (Station Pressure Controllers and Speed Controllers are the same basic instruments.)

3. Taylor FULSCOPE* Controllers give high accuracy and rapid response to load changes. Their dependability has been proven in over 20 years' of use.

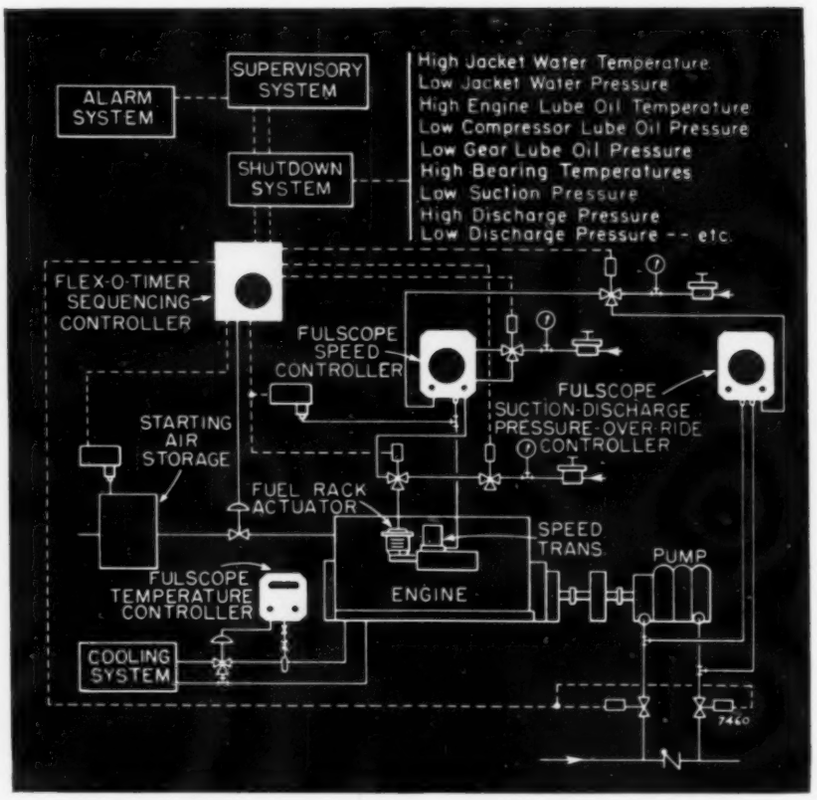
4. It's easy to set up and adjust for optimum station performance.

5. A continuous record of engine speed is available at all times.

The Taylor system shown at right can be applied to reciprocal or turbine gas engines or diesel engines—with remote or local initiation. It can also be modified to suit your specific needs, and flow or specific gravity signals can be incorporated.

Ask your engine manufacturer—he can supply you with Taylor instruments. Or give us details of your present pumping station operation and we'll quote you on a completely automatic system. Taylor Instrument Companies, Rochester, N.Y. and Toronto, Ontario.

*Reg. U.S. Pat. Off.



Typical System (above) for Automatic Start-up and Shut-down of Engines

START-UP

1. Main line valves open.

2. Starting air on and fuel rack opened to starting position after valves are open. (Failure to start simply restarts sequence.)

3. Starting air of engine placed on proportional speed control to come up to idling speed.

4. Engine on proportional-plus-reset speed control for warm-up period.

5. Suction discharge pressure override system adjusts speed control point.

SHUT-DOWN

1. Engine speed reduced to idling.

2. Fuel rack closed.

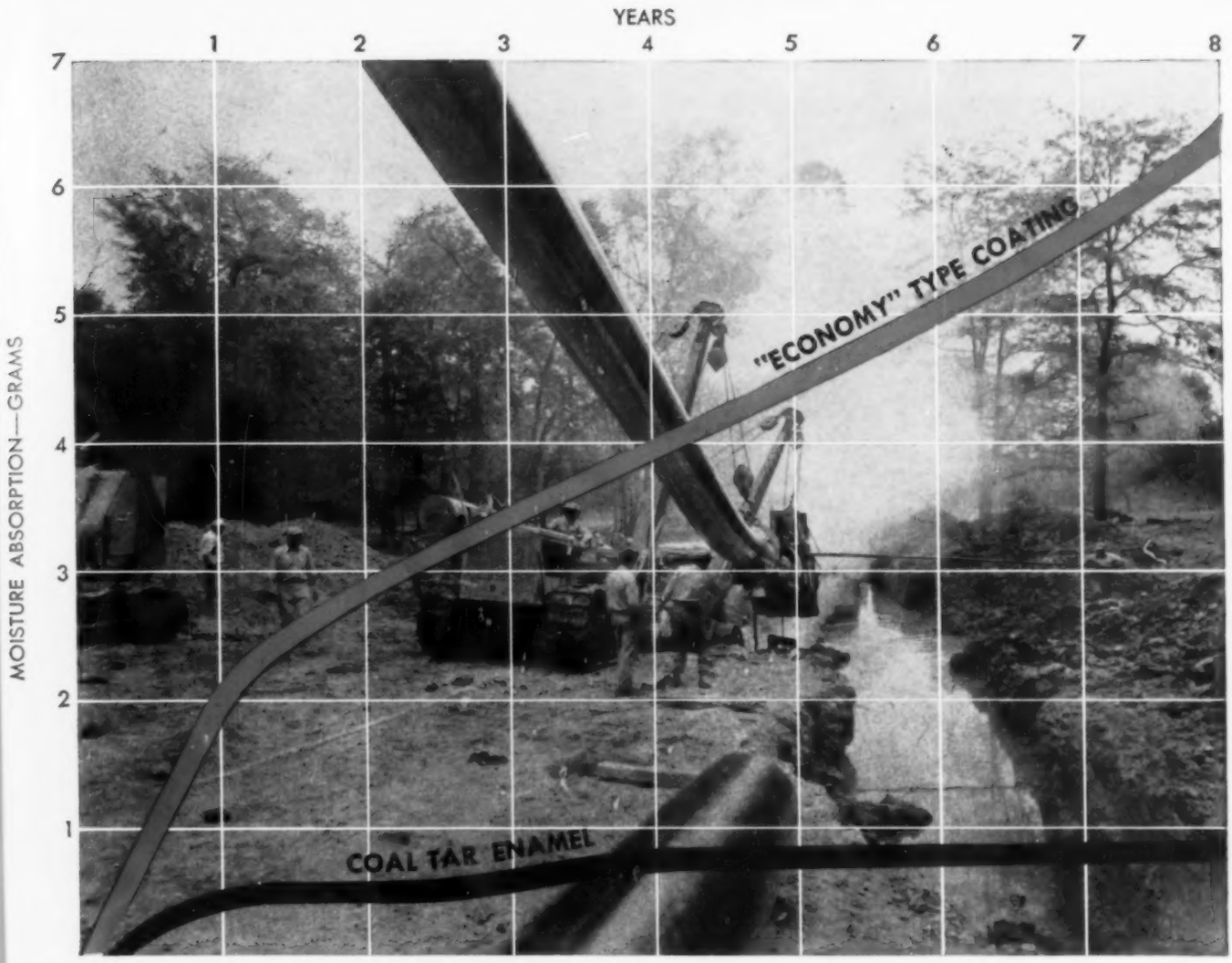
3. Main valves closed.

EMERGENCY SHUT-DOWN

Engine fuel rack and main valves closed.

Taylor Instruments **MEAN ACCURACY FIRST**

MOISTURE ABSORPTION—GRAMS



This Moisture Absorption Comparison Shows Why Most Pipelines are Protected with COAL TAR ENAMELS!

THE chart above, prepared by an independent pipeline engineer*, shows why an overwhelming majority of pipeline owners and operators select *coal tar enamels* to protect their underground investment. No other coating material can *begin* to match the ability of coal tar enamel to resist moisture absorption.

Field tests show that an "economy type" coating exhibits a constant moisture absorption increase. The continuously increasing cost of cathodic protection soon eats up any first-cost savings in material. Peeling and deterioration eventually require expensive reconditioning.

So why risk the chance of costly failures with an "economy" coating or other protection methods not *proved by time?* Specify PITT CHEM Coal Tar Coatings and be *sure* of economical, long-lasting protection.

PITT CHEM maintains a full-time staff of field service men to work with your field men in the efficient application of pipeline enamels. *Write us about your protection requirements . . . today!*

**Name upon request*

★ PITT CHEM® Coal Tar Pipeline Enamels
★ PITT CHEM "Insul-Mastic"® Gilsonite-Asphalt Coatings
★ PITT CHEM "Tarset"® Coal Tar-Epoxy Resin Coatings
★ PITT CHEM "Tarmastic"® Coal Tar Coatings

PROTECTIVE COATINGS DIVISION
PITTSBURGH COKE & CHEMICAL CO.
Grant Building • Pittsburgh 19, Pa.

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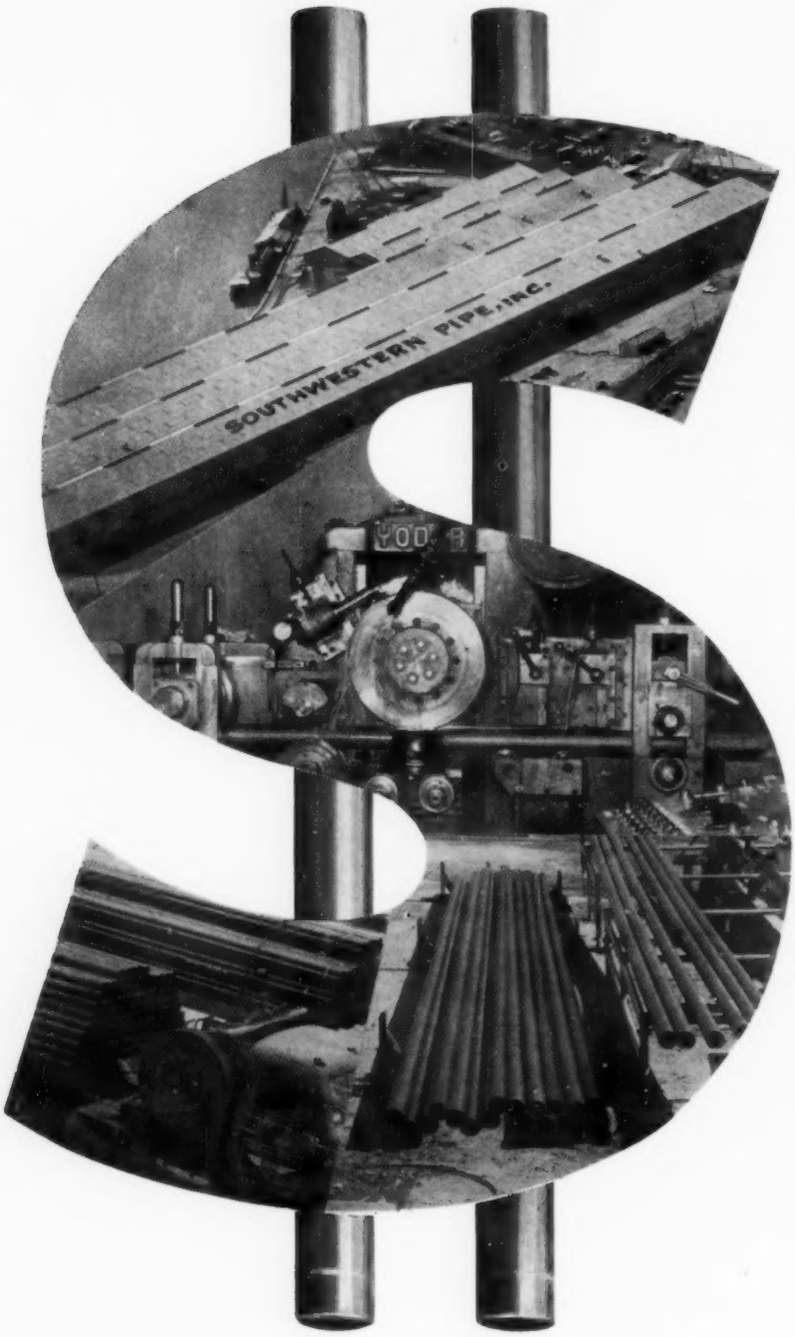
PROTECTIVE COATINGS • COAL CHEMICALS • PLASTICIZERS • ACTIVATED CARBON • CEMENT • COKE • PIG IRON • FERROMANGANESE



LIGHTWALL . . . biggest value for your pipeline dollar

Southwestern LIGHTWALL Electric Resistance-Weld Line Pipe greatly reduces weight without sacrificing performance . . . delivers actual dollar savings four ways over standard-weight pipe. With Southwestern LIGHTWALL, every customer benefits from savings in initial cost, transportation, installation, and in longer life when given proper corrosion protection. Southwestern LIGHTWALL Electric Resistance-Weld Line Pipe is available in a wide range of wall thicknesses to .188" wall, from 1.315" O.D. to 4.500" O.D. Because of Southwestern's manufacturing flexibility and large inventories of selected steel coils, you can depend on prompt deliveries.

LICENSED BY THE AMERICAN PETROLEUM INSTITUTE

SOUTHWESTERN PIPE, INC.*

** Corporate name changed from Southern Sales & Transportation Co., May 1st, 1959*

P. O. BOX 2002 HOUSTON 1, TEXAS PHONE CAPITOL 4-0631

LimiTorque VALVE CONTROLS

...operate 8" GROVE THRU-CONDUIT VALVES ON MANIFOLD, in products pipe line of a large natural gas company

The LimiTorque Valve Operators shown above are of the *Integral Control Type* (another first by LimiTorque) . . . These self-contained "packaged units" offer integral mounted NEMA rated reversing controllers, push-button and indicating light elements . . . The push-button elements, selector switches, etc. are mounted inside the hinged cover for quick, easy accessibility.

LimiTorque "Integral Control" Operators can save up to 50% over separate component equipment and installation costs—and, they are simple, foolproof and absolutely dependable. Send for LimiTorque Bulletin 10-A-58, which completely describes and illustrates these new and exclusive Valve Operators.

LimiTorque is the most widely used automatic valve operator—thousands are operating day and night on Pipe Lines and in Refineries throughout the world. The wide preference for LimiTorque stems from previous performance under all service and climatic conditions: heat, cold, dust, fumes, sleet, snow and rain.

There is no guess work or labor connected with LimiTorque Valve Controls—one key man can open and close any type of valve, quickly and dependably in remote or hazardous locations; thus pipe line and refinery operation procedure can be handled easily and safely.

LimiTorque may be actuated by any reliable power source, such as Electricity, Oil, Gas, Water or Air.

LimiTorque Controls can be field-mounted on existing valves . . . contact your valve manufacturer or nearest LimiTorque sales-engineering office.

THERE IS NO SUBSTITUTE FOR —

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PHILADELPHIA GEAR CORPORATION

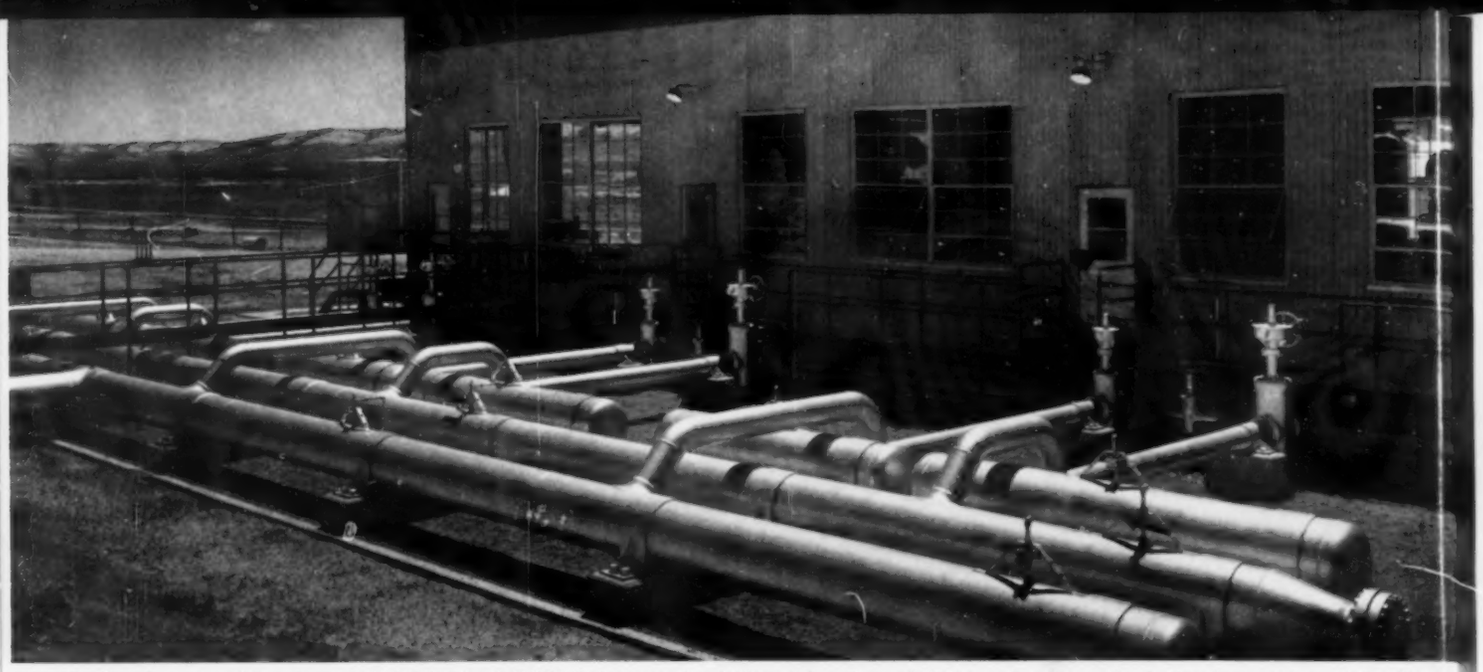
ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS

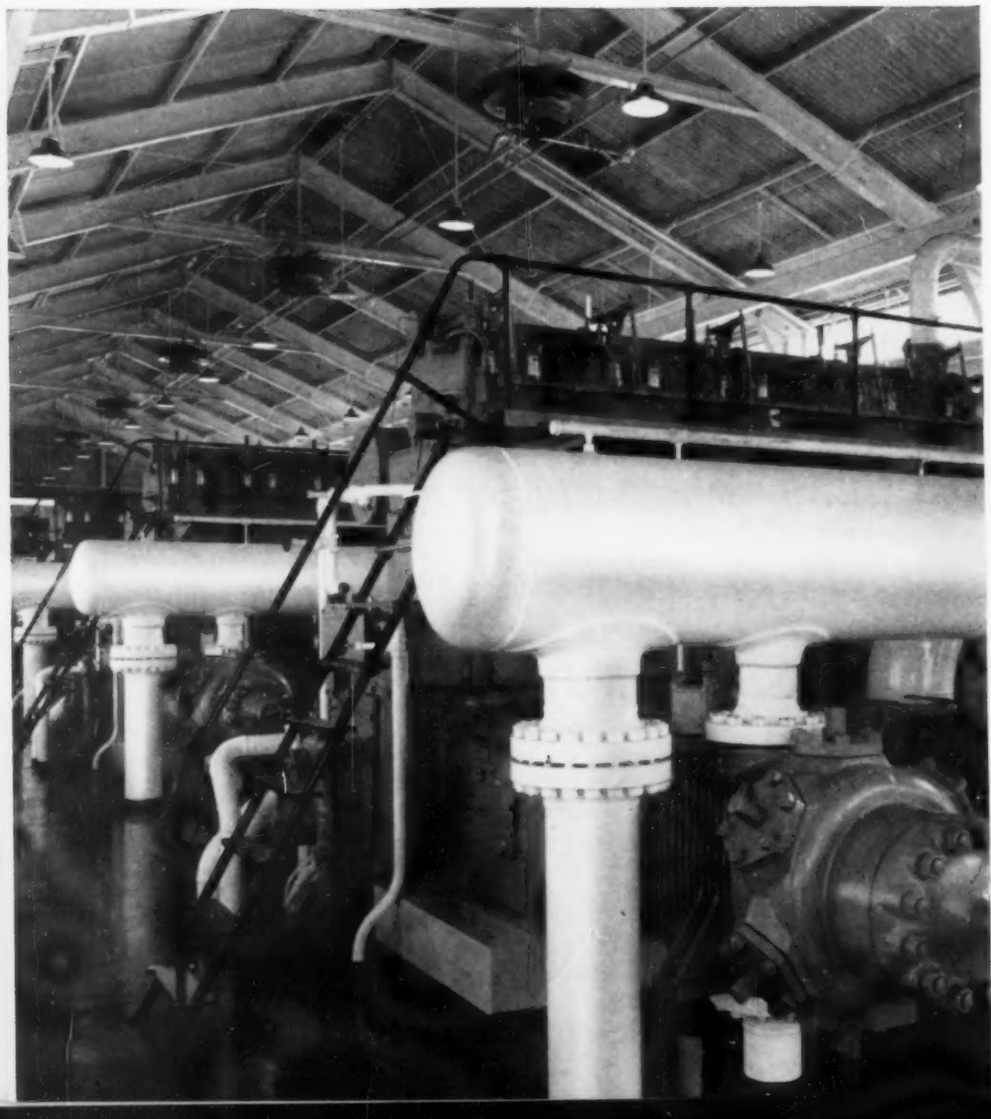
Limitorque Corporation • Philadelphia

For more data on advertised products, use Readers' Service Cards, last page.



ation No. 7, at Kemmerer, Wyoming, rated at 5,060 hp, is 7,325 ft above sea level. Mayari R suction and discharge headers and pulsation dampeners are in the foregro

Bethlehem Compressor Statio Pi Stations on the Pa



The Pacific Northwest Pipeline

ranks with the most challenging of all pipeline projects—in total length, in size of pipe, in difficulty of the terrain, in severity of weather encountered during construction, and in the speed with which the job was completed. The remarkable success of the planners and constructors in overcoming obstacles is well-known to all pipeliners.

The 1,487-mile main line (26-in. OD) is unusual in that it is supplied at both ends, as well as at various intermediate points. Its southern terminus is at Ignacio, Colorado, in the San Juan Basin. Its northern terminus is at Sumas, on the Canadian border, where it ties in with a line from the Peace river fields. Gas is also delivered from the Piceance Creek and Rangely fields in Colorado, and Wyoming's Big Piney. Laterals bring total length of the line to well over 2,500 miles.

Fish Engineering Corporation handled all of the design, engineering, and station layout work, while Fish Northwest Constructors, Inc., were responsible for construction of the stations as direct agents for the owner, Pacific Northwest Pipeline Corporation.

This is Compressor Station No. 1 at Ignacio, Colorado, with 22-in. OD Mayari R suction and discharge bottles in evidence. Largest station on the system, its seven 2,000-hp units discharge gas to the line at 800 psi.

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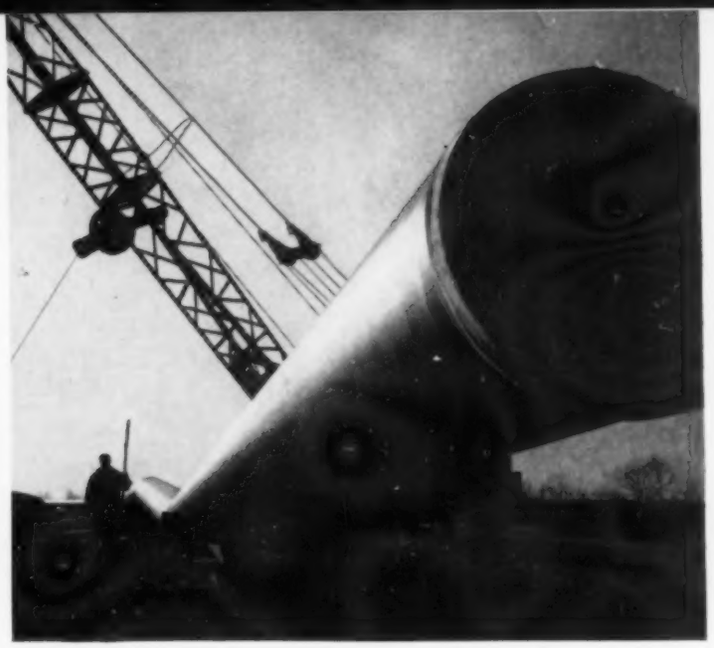


IN NEW JERSEY—36-in. OD Bethlehem line pipe being installed for a major transmission line. Numerous pipeline companies are already considering the economies of 42-in. pipe now available from Bethlehem.

Pipe Was Used at All Thirteen Pacific Northwest Pipeline

THERE are thirteen compressor stations, totalling 82,780 horsepower, along the 1,487-mile main line of the Pacific Northwest Pipeline. For these vital installations the Fish Engineering Corporation specified Bethlehem's Mayari R compressor station pipe—*exclusively*. It was used in 22-in. and 26-in. sizes for suction and discharge lines, headers, and bottles, and for pulsation dampeners.

Why? Because Mayari R high-strength, low-alloy steel is extremely strong (yield point, 50,000 psi min) and ductile (22 pct min elongation in 2 in.). It's highly recommended for applications subject to high pressures, pulsation, and vibration. And it's readily weldable, too.

Mayari R pipe is available in diameters from 18 in. up. It does not require heat treatment. Bethlehem supplies Mayari R plate to fabricators of elbows, tees, flanges, and other fittings.

, Line Pipe to 42 in. OD. At Steelton, Pa., we produce API pipe, electric-fusion-welded and hydraulically expanded, from 18-in. to 42-in. OD, with walls to ¾ in. in all diameters. Electric resistance-weld pipe from 5⁹⁄₁₆ in. to 16 in. OD, and continuous buttweld pipe from ½-in. to 4-in. nominal, are produced to standard API line pipe specifications on our Sparrows Point, Md., pipe mills.

For more information about Bethlehem line and compressor station pipe, please contact the Bethlehem sales office nearest you. Ask for a copy of our new publication, Booklet 519, containing useful design tables concerning sizes 18 in. to 42 in., inclusive.

IN CALIFORNIA—Lines of Beth-Co-Weld pipe carry product from 24 wells to an automatic trap farm. Many miles of this reliable line pipe are used each year by the oil and gas industries.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

new **S&J** *Breather Valves*

Materially Reduce Storage Tank Vapor Loss

New Shand and Jurs model ST-9749 diaphragm-type breather valves are a major achievement in storage tank venting and vapor conservation.

They provide resistance to sticking, corrosion and freezing never before offered. In addition they require practically no maintenance feature non-wetting teflon-on-fiberglas diaphragms for maximum performance and longer life; completely eliminate critical drain holes or other areas that require continuous checking. Ruggedly built from aluminum and stainless steel, ST-9749 breather valves are lightweight, and already available in 4″, 6″, 8″, and 10″ sizes. Call your nearest S&J branch office or sales representative for Technical Bulletin 52D-ST-9749 Breather Valve.

SHAND AND JURS

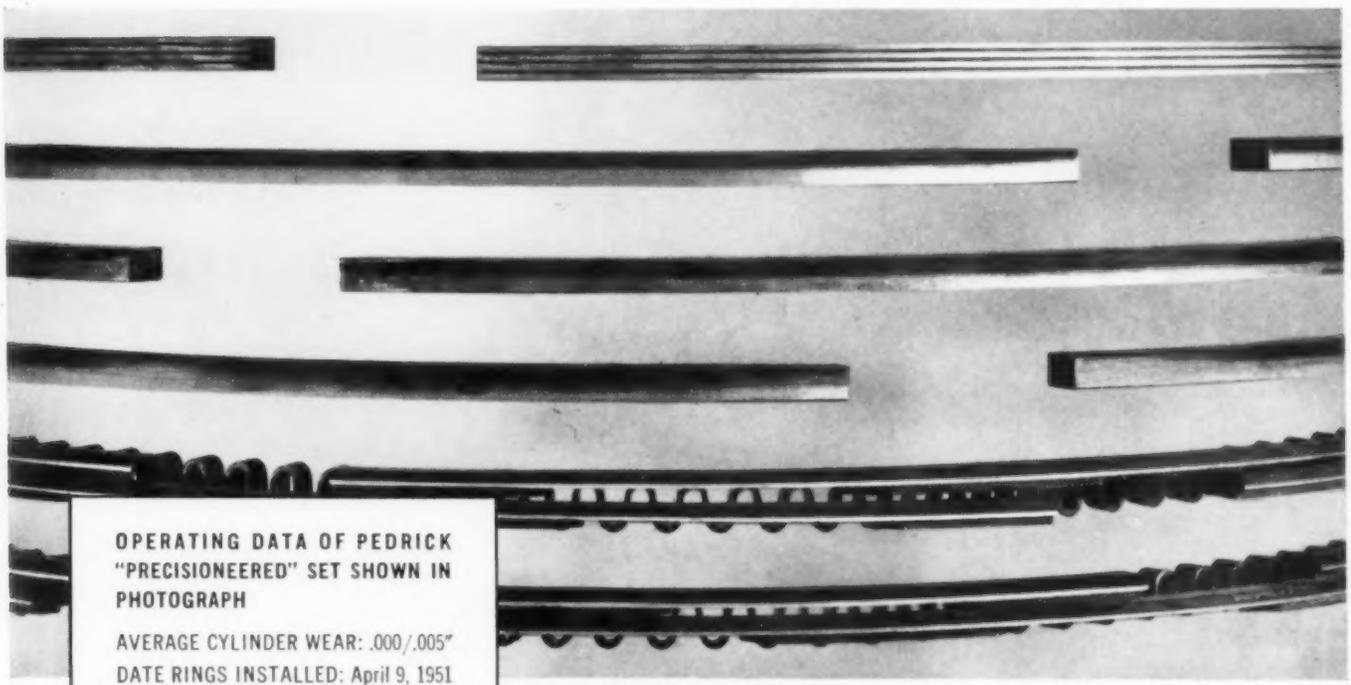
GENERAL PRECISION EQUIPMENT CORPORATION GPE

2600 Eighth Street, Berkeley, California
Branch offices and representatives in principal cities

40,622 hours of operation

. . . an average of 6,350 h.p. hrs. per gal. total lube oil consumption.

The photograph shows Pedrick Piston Rings removed from a Cooper-Bessemer GMVTF 10 cylinder engine after 40,622 hours of operation. Note carefully how the face-wear on the rings (the bright area) extends only half way up. After more than six years of *full load* service, these Pedrick rings are practically as good as new.



OPERATING DATA OF PEDRICK "PRECISIONEERED" SET SHOWN IN PHOTOGRAPH

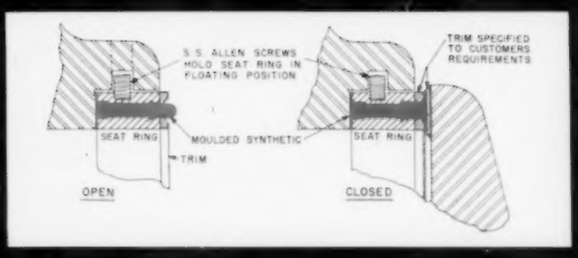
AVERAGE CYLINDER WEAR: .000/.005"
DATE RINGS INSTALLED: April 9, 1951
DATE RINGS REMOVED: June 27, 1957
TYPE LUBE OIL: DTE No. 3 MAGNOLIA
RATED HORSEPOWER: 1100
MAXIMUM OVERLOAD: 10%
LUBE OIL CONSUMPTION: CRANKCASE—39,600 H.P. Hours per Gal. LUBRICATORS—(14 qts. per day) 7,530 H.P. Hours per Gal.
TOTAL LUBE OIL CONSUMPTION (CRANKCASE AND LUBRICATORS): 6,350 H.P. Hours per Gal.

For longer life at full power, make Pedrick "Precisioneered" Piston Ring Sets your *standard* replacement sets. You'll find your Pedrick engineer will be glad to call and help you solve any special problems. Write, wire or phone:
WILKENING MANUFACTURING CO., Phila. 42, Pa.
In Canada: Toronto 2.

Pedrick PISTON RINGS

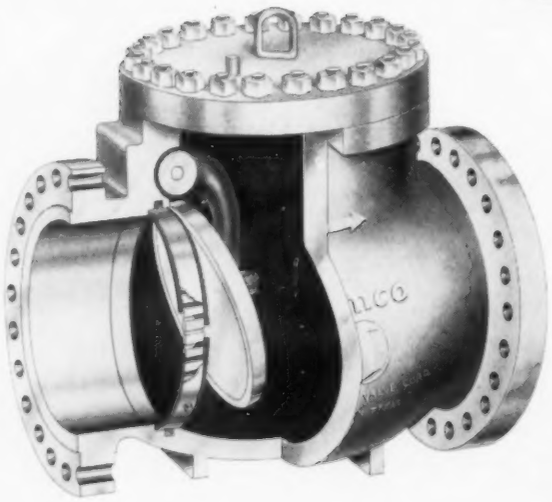
PEDRICK PIONEERED CONFORMABLE PISTON RINGS FOR BIG-BORE ENGINES

A TRUE FLOATING SEAT RING
that maintains
A POSITIVE SEAL
under ALL conditions



SO UNIQUE • It's Patented **SO SUPERIOR** • It's Specified by Name

shimco *patent-seal valves*



NON-SLAM CHECK VALVE Handles all types of fluids, gases or vapors with complete safety and dependability. The swing arm pivots on a hydraulic control. This action assures shock-free operation under all conditions entirely independent of line pressure. The clapper closes quickly, because full dampening action is applied only for the final degrees of the stroke. *Five seconds is the normal closing time.* Hydraulic control, clapper or seat ring can be replaced quickly and easily in the field with the valve still in the line! Proved in performance by 60 major companies. Write for new Shmco Patent-Seal Check Valve folder.

PATENT-SEAL VALVE CORP

2516 WROXTON ROAD **HOUSTON 5, TEXAS**

Conventional Check Valve *Non-Slam Check Valve* *Dual Non-Slam Check Valve* *Rising Stem Gate Valve* *Full Conduit Gate Valve* *Lift-Plug*
Block Valve *Basket-Type Strainer* *Self-Cleaning Strainer* *Red-Rex Union* *Custom-Coated A.P.I. Rings*

PIPE LINE PANORAMA

Contracts Let for Major Projects . . . Pipe line construction has finally pulled out of the "Memphis Decision" doldrums. During June, contracts were awarded on more than 1,000 miles of natural gas lines, with action expected soon on an additional 2,500 miles.

Major contracts awarded include Midwestern's 350-mile, 30-inch line from Portland, Tenn., to Joliet, Ill.—to be constructed by Grayco Constructors; Sharman, Allen, Gay and Taylor; Panama Inc.; Majestic Contractors; Bechtel Corporation.

Southern Natural has awarded contracts on its 355-mile expansion program in Georgia and Louisiana to Oklahoma Contracting, C.S. LeNoir Construction, Harbert Construction, Buchanan Contracting, and Sharman, Allen, Gay, and Taylor.

Northern Natural's 150 miles of 30-inch loops in Nebraska, Iowa, Minnesota, and Kansas will be built by R. H. Fulton.

O. R. Burden has been awarded contract to lay 100 miles of gas gathering lines in south Texas for Coastal States Producing Company.

Trunkline has announced awarding of contracts on 204 miles of mainline extension in Illinois and Indiana; about 500 miles of loops in Texas, Louisiana and Illinois; plus several gathering and lateral lines in Louisiana (See Page 75).

Transwestern's application to build 1,800 miles of 24-30-inch line from Texas-Oklahoma panhandles to California is expected to be approved shortly. Houston Contracting, H. C. Price, and R. H. Fulton would build the line.

Progress Report on New Pipe Inspection Methods . . . Ultrasonics, fluoroscopes and eddy currents are the basis for improved pipe inspection methods that either are now in use, or will be in the near future.

Ultrasonic method for natural gas systems is being developed for Southern Gas Association at Southwest Research Institute. Unit utilizes multiple ultrasonic devices which move over entire surface of pipe at high speed. Electronic circuitry automatically recognizes and classifies defects on various sizes of pipe. Complete automatic inspection device is expected to be ready for field trial within a year.

Fluoroscopic inspection of large diameter submerged arc-welded pipe is in experimental stage at McKeesport plant of National Tube Division, U.S. Steel. Pilot installation includes 48-foot long X-ray head mounted on the end of a boom, and recently developed image intensifier that clearly indicates defects. The unit, put into plant operation last January, works equally well for binocular or TV viewing.

Farrowtest, now on production line at Republic Steel's Youngstown plant, depends on electronic induction of eddy currents into pipe from a series of detecting coils. Pipe having defect on surface, or anywhere within the wall, distorts flow pattern of eddy currents. Distortion is instantly analyzed electronically, and reject signal is sent to control panel where it activates indicators which record defect on oscillograph chart, automatically marking location of defect. Rejection of pipe is thus automatic, positive and independent of operator judgment.

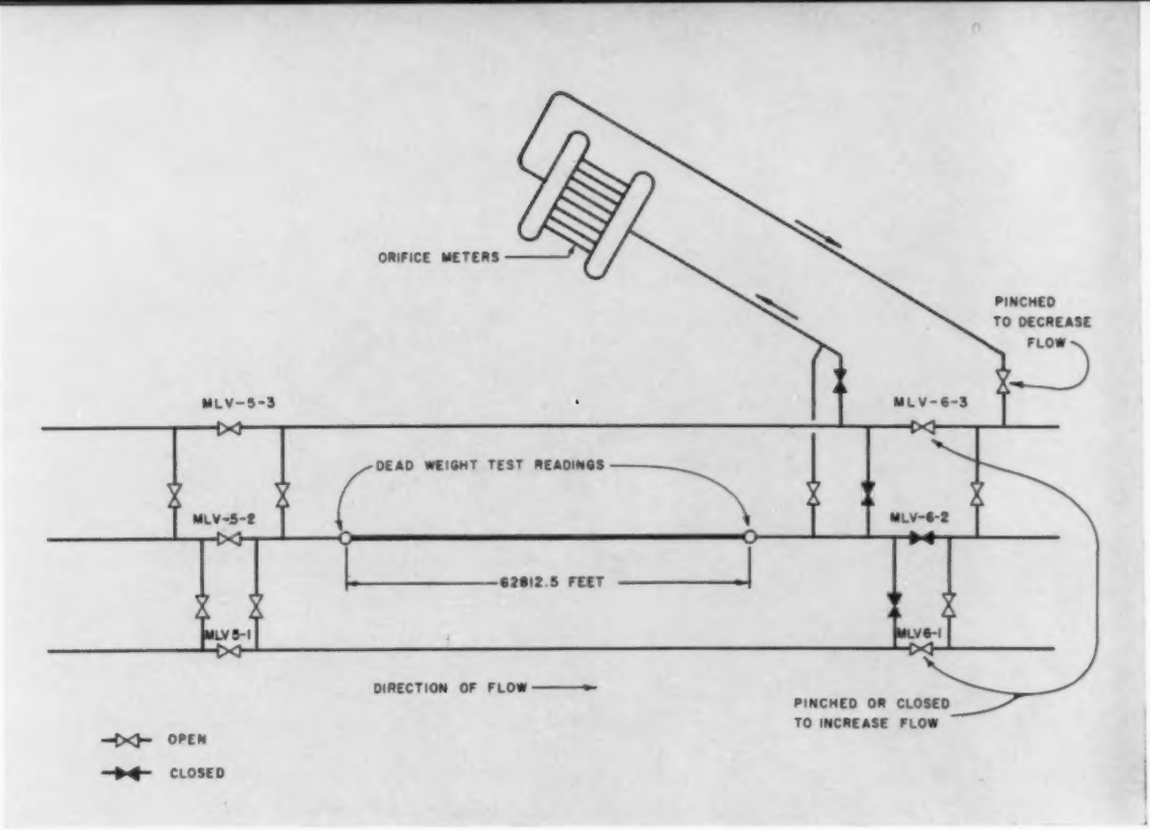


FIGURE 1—Schematic of the test area. Shown in the upper portion of the drawing is the large diameter orifice meter testing site used some years back by AGA.

TGT Reports . . .

Flow Tests on Internally, In-Place Coated Pipe

Here's a summary of results of tests conducted on the effects of internal cleaning and coating of gas pipe lines

By C. H. Klohn
Tennessee Gas Pipeline Co., Houston

A SERIES OF FLOW tests conducted on a 11.9-mile section of 24-inch natural gas pipe line indicate that at certain flow rates deliverability can be increased by (1) Cleaning—if the line is dirty and (2) internally coating with epoxy resin formulations. Between 150 MMcfd and 450 MMcfd, thruput was increased by five to 10 percent depending on the rate of flow. This increase breaks down into an almost constant 4 percent increase directly attributable to cleaning (in this instance, the line had not been cleaned in 10 years) and an additional one to six percent increase directly attributable to internal coating.

This program was a joint one conducted under the auspices of the organizations shown elsewhere in this article. The test site and the pipe line were furnished by Tennessee Gas Pipeline Co.; it should be pointed out that the line is typical of the large diameter gas transmission lines constructed 10 years ago. The line had not been cleaned since it originally went into service, and it is located immediately upstream from the test site used in AGA large diameter orifice meter testing some years back.

There is only a slight change in elevation between the upstream and downstream ends of this portion of pipe line which contains 79 wrinkle bends, 81 percent of which are between four and six degrees. All of the gas passing through this section has been dehydrated; a large portion has been processed by gasoline plants, which have removed the heavier hydrocarbons.

The project was organized in three phases:

Phase 1: The section was tested after 10 years operation.

Phase 2: The section was cleaned with two separately run wire brush type pigs. The section was tested after cleaning.

FIGURE 2—First step in Phase 3 of the TGT test program consisted of wire brush cleaning of the 11.9 mile section of line. Two pigs were used for cleaning and the line was blown down to remove dry materials.

Phase 3: The section was cleaned and coated. Two wire brush type pigs were used in the cleaning, and then a 3,000 gallon plug of methyl ethyl ketone was used as a detergent. The line was then coated with an epoxy coating. The section was tested after coating.

It is well known that the present gas flow formulas are based upon certain premises which do not always occur. For use in the solution of the many and varied problems that arise in the operation or expansion of gas transmission facilities, the engineer must make an estimate of deliverability. To do this, he needs to know the limitations of the formulas and an accurate correction factor to correct for the discrepancy in the formula. To determine the feasibility of ammonia displacement as one of the ways this factor may be otbained, tests were performed in Phase 1 and Phase 3.

ANALYSIS	COLS. 8-9 ANALYSIS CODE	COLS. 10-13 MOL. FRACTION	GPM 14.696 PSIA & 60° F	SP. GR. & 60° F (AIR = 1)
CARBON DIOXIDE	01	0.0028		0.0043
NITROGEN	02	0.0028		0.0027
METANE	03	0.9469	16.049	0.5255
ETHANE	04	0.0344	0.574	0.0360
PROPANE	05	0.0097	0.266	0.0150
ISO-BUTANE	06	0.0020	0.065	0.0041
N-BUTANE	07	0.0009	0.028	0.0019
ISO-PENTANE	08	0.0005	0.018	0.0013
N-PENTANE	09			
HEXANES	10			
HEPTANES PLUS	11			
TOTAL		1.0000	17.300	0.5908

FIELD DATA:
PRES. 690 PSI — TEMP. 78 °F — SP. GR. 0.597 — H2O D. P. 47 °F & 690 PSI — HYD. D. P. 48 °F & 690 PSI
BTU —
SAMPLE Natural Gas
TAKEN BY O. L. Wilson
DATE 11-20-58
BOMB NO. E 6462

LAB. DATA:
ANALYSIS NO. 1568
DEV. TEST NO. 4094-95
ANALYSIS BY Charles E. Richardson
SP. GR. (BAL.) 0.597
SP. GR. (CALC.) 0.591
BTU (DRY) ** 1056
BTU (WET) ** 1038
BTU (DETERMINED)

REMARKS: **BTU/cu. ft. at 14.73 PSIA at 60° F

FIGURE 3—Typical gas sample analysis.

Practical Smooth Pipe Law. Apparently, the test results of pipe in operational use are somewhat different than those obtained under laboratory conditions. The writer suggests a "practical" smooth pipe law to correct for this difference.

$$\sqrt{\frac{1}{f}} = 3.84 \log (N_R \sqrt{f}) - 0.64$$

The three most common flow equations used by the gas industry are the Weymouth, Panhandle A and Panhandle B. Figures 8, 9, and 10 illustrate the relative difference between the formulas. The deviation factor is present in the orifice meter calculations in Figures 8, 9 and 10, but is not present in the Panhandle A or the Weymouth equations.

The writer feels the results of the ammonia tests show that the calibration of the method depends upon the condition of the interior and the rate of flow. It also seems reasonable to assume that it is dependent upon distance. Figure 12 is a graph of the results of the ammonia tests. However, participants in the A.G.A. NB-13 Pipe Line Committee have concluded that the ammonia rates do not depend upon (a) interior pipe condition (b) rate of flow (c) distance of ammonia travel.

HOW THE TEST WAS CONDUCTED

Procedure. A test consisted of reading deadweight gages, barometers, gas flow temperatures, orifice meter chart differential, and atmospheric temperature every five minutes for a period of 20 minutes. From five minutes to an hour after the first five readings were complete, at least one

FIGURE 4—After dry cleaning of the line with wire brush pigs, a 3,000 gallon plug of methyl ethyl ketone was used as detergent to clean the line before coating. Here two of the rubber ball squeegees can be seen shooting from the test section.

more set of five minute readings were obtained as a check before changing the flow rate. High pressure water manometers were also read every five minutes during most of the tests as a check on the orifice meters. Each of the figures in Tables 1, 2 and 3 represents an average of five five-minute readings.

Specific gravity was obtained once during each flow rate using an ACME gravity balance. If the test period for a flow rate required longer than three hours, specific gravity was determined again. To examine the continuity of gas quality throughout the three phases, water dew point and hydrocarbon dew point were observed once during each flow rate. In addition, two gas samples were taken at random during each phase for analysis and deviation tests.

Tests of this type depend upon absolute control over the immediate area, and the cooperation of operating and testing personnel. This was accomplished by constant radio contact and periodic time checks to assure simultaneous readings at the separated locations.

Establishing Flow Rate. Increasing the flow through the section over normal operational flow was accomplished by pinching or closing MLV 6-3 and/or MLV 6-1 (see Figure 1). Decreasing to less than normal operation was accomplished by pinching the outlet valve at the

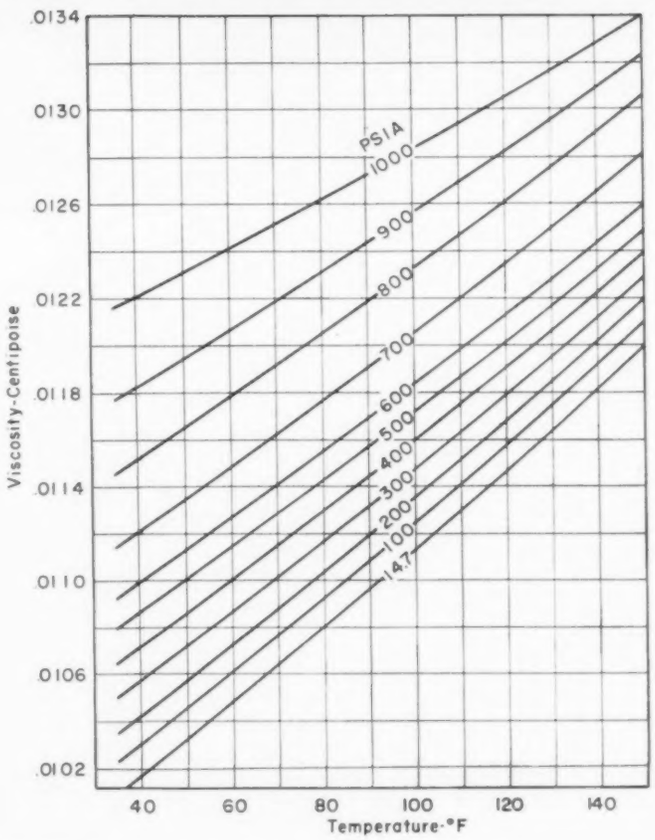


FIGURE 5—Dynamic viscosity of a 0.595 gravity natural gas calculated by method of Carr, Kobayashi, and Burrows.

TABLE 1

Test	Date	Starting Time	Remarks	P_1 PSIA	P_2 PSIA	dp_c	Qm MMCFD	G	T_1 °F	T_2 °F	Average $\frac{1}{z}$	f	Viscosity M x 10^6	N_R x 10^{-3}	$\sqrt{\frac{1}{f}}$	Darcy Coefficient f_o
1-A	11- 3	1:55	.....	731.17	713.56	0.30	191.06	.603	75	74.5	1.1074	.002552	7.90	8,560	19.80	.01021
1-AR		2:55	.....	730.91	713.40	.30	191.18	.603	75	74.5	1.1074	.002533	7.90	8,566	19.86	.01013
1-B	11- 3	4:35	.....	735.24	708.96	.29	235.16	.596	74.5	74.5	1.1030	.002549	7.90	10,414	19.81	.01019
1-BR		5:30	.....	734.88	708.50	.29	235.99	.596	74.5	74.5	1.1030	.002539	7.90	10,451	19.85	.01015
1-C	11- 4	2:35	.....	693.38	655.61	.27	274.20	.594	74	73	1.0967	.002525	7.80	12,257	19.90	.01010
1-CR		3:45	.....	691.46	653.91	.27	273.38	.594	74	73	1.0967	.002519	7.80	12,221	19.92	.01007
1-CR1		4:25	.....	691.40	653.57	.27	274.53	.594	74	73	1.0967	.002516	7.80	12,272	19.93	.01006
2-A	11- 5	1:10	.....	714.08	656.10	.27	342.82	.595	74	73	1.0985	.002525	7.82	15,311	19.90	.01010
2-AR		1:50	.....	713.19	654.91	.27	342.63	.595	74	73	1.0985	.002537	7.82	15,303	19.86	.01015
2-B	11- 5	4:05	.....	719.64	645.19	.27	389.01	.595	73	72.8	1.0995	.002516	7.82	17,374	19.94	.01006
2-BR		4:35	.....	719.13	644.86	.27	388.71	.595	73	72.8	1.0995	.002512	7.82	17,361	19.96	.01005
2-C	11- 6	1:50	.....	730.83	639.62	.27	430.92	.597	74	72	1.0993	.002515	7.82	19,311	19.94	.01006
2-CR		2:20	.....	730.32	638.90	.27	430.91	.597	74	72	1.0993	.002518	7.82	19,310	19.92	.01007
3-A	11- 7	11:10	.....	731.33	716.78	.29	174.55	.596	74	74	1.1031	.002548	7.90	7,730	19.80	.01019
3-AR		12:20	.....	731.47	716.91	.29	174.04	.596	74	74	1.1031	.002565	7.90	7,707	19.75	.01026

TABLE 2

Test	Date	Starting Time	Remarks	P_1 PSIA	P_2 PSIA	dp_c	Qm MMSCFD	G	T_1 °F	T_2 °F	Average $\frac{1}{z}$	f	Viscosity M x 10^6	N_R x 10^{-3}	$\sqrt{\frac{1}{f}}$	Darcy Coefficient f_o
1-A	11-17	11:35	.....	736.39	720.04	.29	192.72	.597	74	75	1.1037	.002362	7.89	8,560	20.58	.009451
1-AR		12:10	.....	736.55	720.24	.29	192.99	.597	74.5	75	1.1037	.002349	7.89	8,572	20.64	.009398
1-B	11-17	2:30	.....	739.08	714.95	.29	237.87	.594	74.5	75	1.1037	.002309	7.90	10,499	20.81	.009236
1-BR		3:00	.....	738.47	714.31	.29	238.00	.594	74.5	75	1.1037	.002308	7.90	10,504	20.82	.009229
1-C	11-17	5:15	.....	742.59	706.62	.29	290.57	.598	75	73	1.1040	.002297	7.90	12,911	20.87	.009186
1-CR		5:40	.....	742.77	706.30	.29	291.46	.598	75	73	1.1040	.002315	7.90	12,951	20.79	.009257
2-A	11-18	1:30	.....	707.42	653.22	.27	346.89	.593	75	73	1.0977	.002293	7.82	15,443	20.89	.009171
2-AR		2:05	.....	706.30	652.18	.27	346.61	.593	75	73	1.0977	.002290	7.82	15,429	20.90	.009158
2-B	11-18	4:15	.....	708.66	640.07	.27	389.12	.593	75	72.5	1.0978	.002290	7.81	17,343	20.90	.009158
2-BR		4:45	.....	708.41	639.62	.27	389.86	.593	75	72.5	1.0978	.002287	7.81	17,376	20.91	.009145
2-C	11-19	12:00	Very Unstable	718.57	639.72	.27	423.02	.592	74	72.5	1.0985	.002251	7.81	18,822	21.08	.009005
2-CR		4:15	Very Unstable	693.67	618.52	.26	405.22	.594	74	72	1.0944	.002244	7.78	18,161	21.11	.008975
2-CR1		4:40	Very Unstable	692.15	617.09	.26	404.41	.594	74	72	1.0944	.002245	7.78	18,125	21.11	.008980
3-A	11-20	11:30	.....	719.35	708.98	.29	148.87	.597	74	74	1.1017	.002435	7.88	6,621	20.27	.009740
3-AR		12:50	.....	721.32	710.78	.29	151.47	.597	74	74	1.1017	.002398	7.88	6,736	20.42	.009592
3-AR1		1:20	.....	721.23	710.77	.29	151.00	.597	74	74	1.1017	.002394	7.88	6,715	20.44	.009576

TABLE 3

Test	Date	Starting Time	Remarks	P_1 PSIA	P_2 PSIA	dp_c	Qm MMSCFD	G	T_1 °F	T_2 °F	Average $\frac{1}{z}$	f	Viscosity M x 10^6	N_R x 10^{-3}	$\sqrt{\frac{1}{f}}$	Darcy Coefficient f_o
1-A	12- 8	11:35	.....	726.82	709.50	.29	202.82	.597	70	70	1.1067	.002256	7.85	9,054	21.05	.009024
1-AR		12:40	.....	726.18	708.84	.29	203.16	.597	71	70	1.1067	.002247	7.85	9,069	21.10	.008987
1-AR1		1:15	.....	726.05	708.57	.29	203.14	.597	70.5	70	1.1067	.002266	7.85	9,069	21.01	.009064
1-B	12- 8	3:15	.....	728.67	705.34	.29	239.22	.597	71	70	1.1058	.002186	7.86	10,666	21.39	.008746
1-BR		4:10	.....	728.46	704.83	.29	239.86	.597	70	69.5	1.1068	.002207	7.84	10,721	21.28	.008829
1-C	12- 9	11:40	.....	731.88	696.98	.29	297.01	.597	70	69	1.1061	.002128	7.84	13,276	21.68	.008511
1-CR		12:25	.....	731.49	696.12	.29	298.75	.597	70	69	1.1061	.002130	7.84	13,354	21.67	.008519
1-AR2	12- 9	4:35	.....	723.79	706.92	.29	200.59	.593	70	69	1.1067	.002254	7.84	8,906	21.06	.009016
1-AR3		5:25	.....	724.80	708.11	.29	200.52	.593	70	69	1.1067	.002234	7.84	8,903	21.16	.008937
1-AR4		5:50	.....	725.22	708.55	.29	200.60	.593	70	69	1.1067	.002231	7.84	8,907	21.17	.008925
2-A	12-10	11:55	.....	716.76	667.26	.29	350.48	.594	70	68	1.1027	.002111	7.78	15,708	21.76	.008442
2-AR		1:05	.....	716.29	666.85	.29	350.40	.594	70	68	1.1027	.002108	7.78	15,704	21.78	.008430
2-B	12-10	3:05	.....	720.30	661.16	.29	386.42	.594	70	68	1.1025	.002072	7.78	17,318	21.96	.008288
2-BR		4:10	.....	720.35	660.80	.29	387.00	.594	70	68	1.1025	.002080	7.78	17,344	21.92	.008319
2-C	12-11	12:50	.....	722.94	650.48	.28	428.20	.595	68	67.5	1.1033	.002060	7.77	19,248	22.03	.008242
2-CR		1:55	.....	723.61	650.43	.28	431.49	.595	67	67.5	1.1045	.002054	7.76	19,421	22.06	.008218
2-D	12-11	4:05	.....	731.00	640.68	.28	485.34	.595	68	67	1.1028	.002018	7.76	21,844	22.26	.008069
2-DR		5:05	.....	731.08	639.93	.28	487.32	.595	69	67	1.1028	.001998	7.77	21,905	22.37	.007990
2-DR1		5:35	.....	730.23	639.37	.28	486.03	.595	69	66.5	1.1028	.002001	7.77	21,847	22.35	.008002
3-A	12-12	12:10	.....	724.43	712.50	.29	165.62	.595	68	69	1.1073	.002329	7.83	7,388	20.72	.009316
3-AR		1:00	.....	725.09	713.11	.29	165.70	.595	68	69	1.1073	.002338	7.83	7,391	20.68	.009355
3-AR1		2:00	.....	725.69	713.73	.29	165.74	.595	66	69	1.1085	.002342	7.82	7,402	20.66	.009371
3-AR2		2:40	.....	725.95	713.98	.29	165.58	.595	68	69	1.1073	.002343	7.83	7,386	20.66	.009372
3-AR3		3:30	.....	725.30	713.52	.29	165.00	.595	68	69	1.1073	.002320	7.83	7,360	20.76	.009277
3-AR4		3:55	.....	725.17	713.41	.29	164.93	.595	68	69	1.1073	.002317	7.83	7,357	20.78	.009266

FIGURE 6—Final step in preparing the internal surface of the line was application of epoxy coating. A specially designed coating application plug is taken from the line. Average calculated coating thickness was approximately six mils.

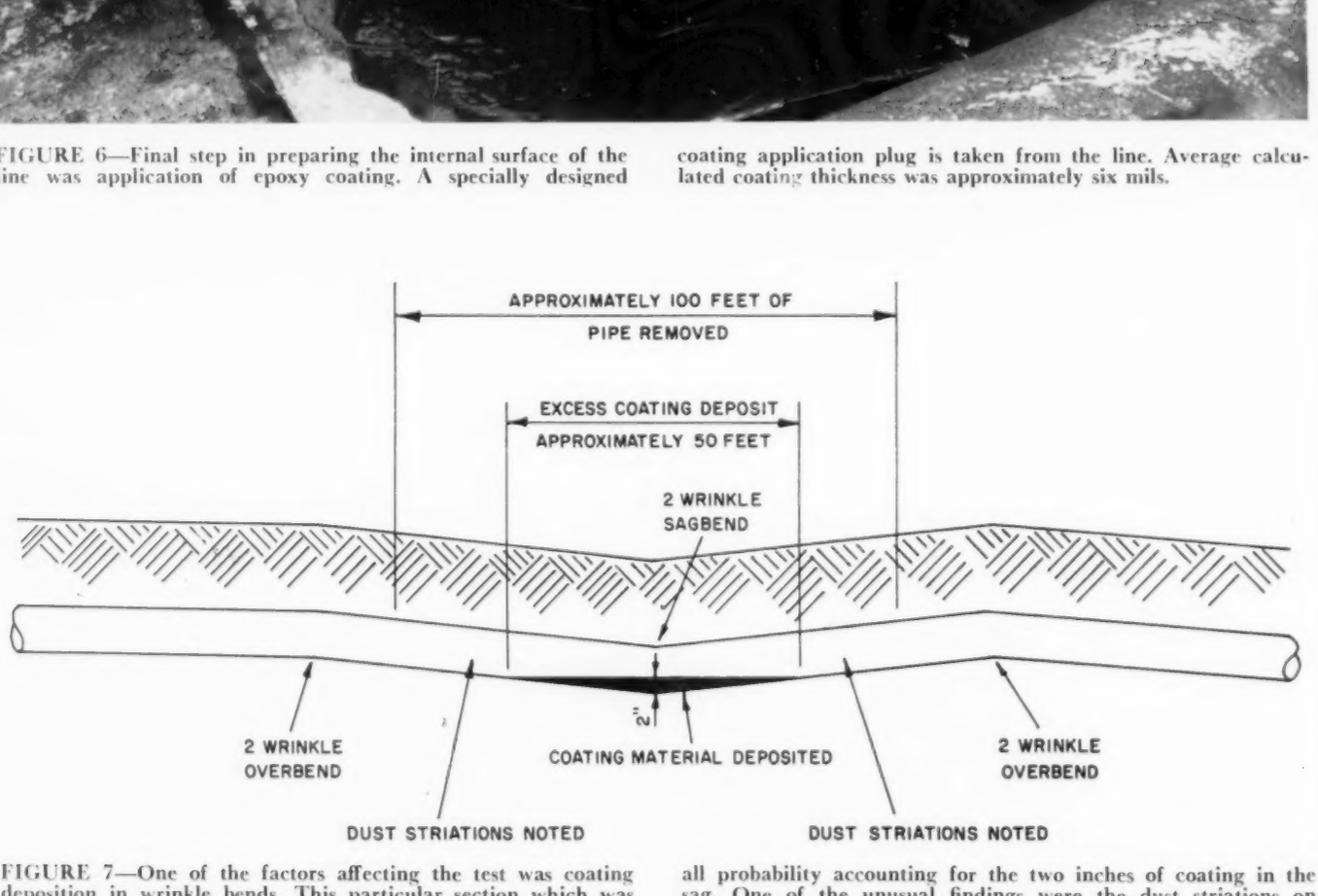


FIGURE 7—One of the factors affecting the test was coating deposition in wrinkle bends. This particular section which was removed after the test runs slowed pigs which traversed it, in all probability accounting for the two inches of coating in the sag. One of the unusual findings were the dust striations on either side of the sag.

measurement site. All crossovers were opened at MLV 5 and downstream crossovers were opened at MLV 6. Pinching or closing was done slowly in order to stabilize the immediate pipe line system more quickly. After the differential was stabilized (by observing orifice meter charts) an additional one to two hours was required for the pressures to stabilize.

Definition of Stabilization. Perfect stability (steady state) is next to impossible to attain in a gas transmission system, therefore arbitrary limitations were set on the amount of change of differential and pressure.

If orifice meter differential was changing at a rate of no more than 0.4 inch in 20 minutes, and pressures at MLV 5 and MLV 6 were changing at no more than 0.1 psi in five minutes, with the pipe line pressure differential remaining nearly constant, the line was considered stable, and testing was begun. During a few of the tests at the higher flow rates, these limitations were slightly exceeded.

Variations of pressure and differential were far below the arbitrary maximums during all of the tests at the lower flow rates. A forced change in gathering system operation produced a very high degree of instability during Phase 2. This occurred when trying to attain a rate of 450 MMcfd. The data taken during this instability is reproduced in Table 2 for those who wish to treat it for confirmation of some of the published literature on transient flow.

Smoothness-Roughness Effects. Experiments have shown that the resistance coefficient is a function of Reynolds Number when the flow is laminar, or streamline. As the flow laminations are broken, a family of curves develop. These curves of the resistance coefficient are a function of Reynolds Number and the relative roughness of the pipe.

The relative roughness is a dimensionless ratio of interior surface roughness to pipe radius. The lower limit of the resistance coefficient is termed the "Smooth Pipe Law."

As the degree of turbulence increases, the resistance coefficient departs from the smooth pipe law and becomes a constant. It is then a function of relative roughness only. The family of constants is termed the "rough pipe law."

Previous Experiental Work. Experiments by Nikuradse[6] laid much of the groundwork for present day methods of analysis. However, he created an artificial roughness of the interior by using uniformly screened grains of sand, and experimented with rather small pipe diameters and short distances. Colebrook[7] attempted to mathematically describe the transition from the smooth pipe law to the rough pipe law. The experiments of the Bureau of Mines[1] have shown that the transition from "smooth" to "rough" is much sharper than the Colebrook equation indicates. But again, small pipe diameters and short distances were necessary for the Bureau of Mines tests. The question to be resolved by the Refugio tests therefore, was: *Does the condition of the internal pipe surface have much of an effect upon deliverability in a large diameter pipe in commercial use?*

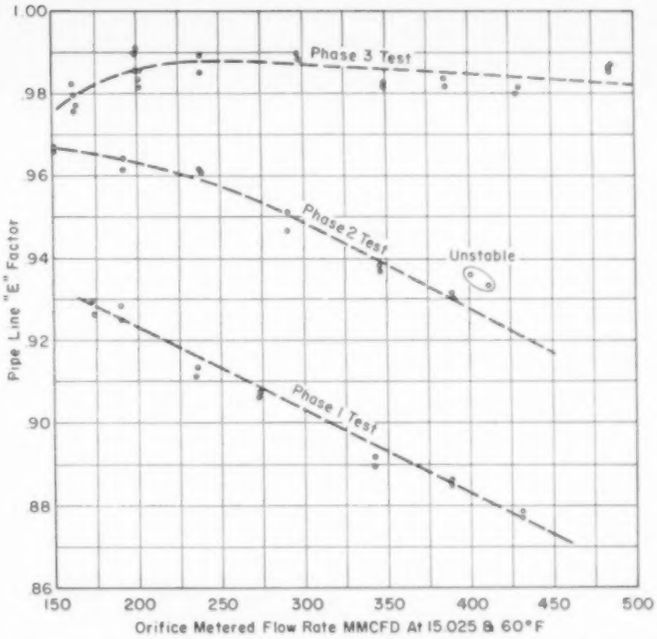


FIGURE 8—Pipe line "E" factor versus flow rate as calculated by the Panhandle "A" formula. (No elevation corrections or deviation applied.)

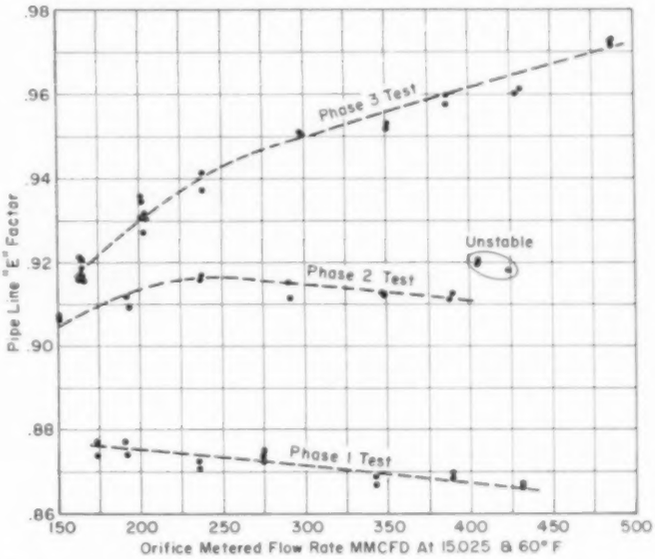


FIGURE 9—Pipe line "E" factor versus flow rate as calculated by the Panhandle "B" formula.

Results. This question is answered by an examination of Figure 11. The total increase in the transmission factor, which is directly proportional to deliverability, varied from approximately five percent at a Reynolds Number of 7,000,000 to about 10 percent at a Reynolds Number of 18,000,000. As calculated by Tennessee Gas Pipeline Company engineers using Nikuradse's[10] rough pipe law, the roughness of Phase 1 was 912 microinches and Phase 2 was calculated at 520 microinches. Phase 3 roughness could not be calculated since the transmission factor did not become constant, but the writer estimates (by continuation of Phase 3 curve) something less than 180 microinches.

Northern Natural's Calculations. Northern Natural Gas Co. Engineers obtained average roughness of 952

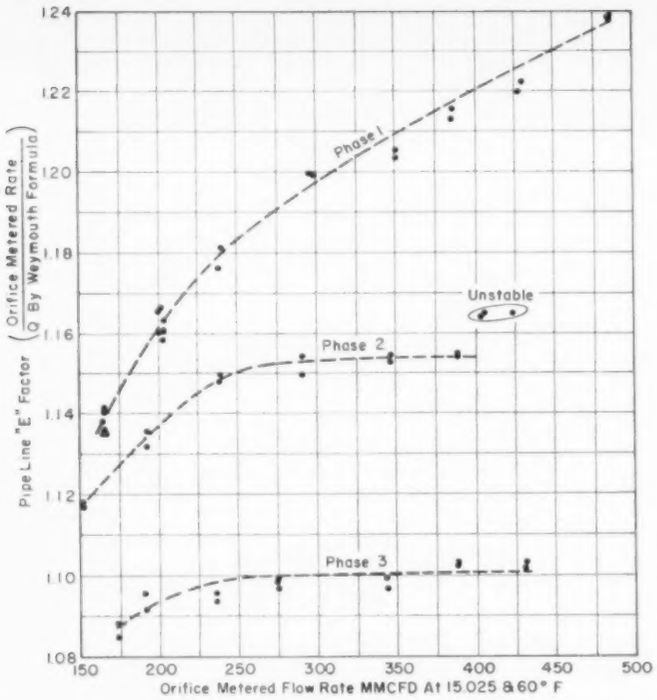


FIGURE 10—Pipe line "E" factor versus flow rate as calculated by the Weymouth equation. (No corrections for elevation or deviation were applied.)

microinches for Phase 1, 573 microinches for Phase 2, and 413 microinches for Phase 3. Northern's computations are averages of all flow values for each phase.

Practical Considerations. Actual measurement of the roughness would have required many separated measurements in order to assure a representative value. This was impractical because of the excavation and cutting required. No distinct line can be drawn to break down the increases which are directly attributable to the cleaning or to the coating, since a wire brush cleaning operation was performed in both phases. However, the glass-like surface of some of the epoxies is well known, and it is a matter of conjecture as to how many wire brush pigs are necessary to attain this smoothness.

Smooth Pipe Law. Figure 11 shows that the tests indicate a smooth pipe law evolving a transmission factor about four percent less than that of Von Karman. There are several reasons for this apparent discrepancy. In order of importance, they are:

1. **The characteristics of commercial use.** The work of The Bureau of Mines was a valuable addition to the knowledge of flow characteristics. It showed that small amounts of liquid or solid material in the pipe line had considerable effect upon deliverability. The Bureau filtered all of the gas in verifying Von Karman's equation for smooth pipe.

   Although the gas used in testing the 24-inch line was dehydrated, and a large portion processed by gasoline plants, it is believed there still was sufficient foreign material present to appreciably affect the transmission factor. The writer believes that any unfiltered stream will produce similar results.

   Foreign material present in natural gas lines can include powdered dessicants, compressor lubricating oil, scrubber oils, valve greases, and condensate, to name a few.

2. **Bends.** Another factor contributing to the discrepancy was the 79 wrinkle bends in the test section. The bends would add some resistance to flow, leading to an error. One way of correcting this error is to use "equivalent" length, rather than actual length. To obtain agreement between the Phase 3 tests and the Von Karman smooth pipe law would call for allowing 63 feet of additional pipe per bend, or 23 feet additional per wrinkle. The writer believes this is far too much to allow, since the wrinkle is a depression of the interior, rather than an intrusion into the interior.

3. **Different roughness.** The total length of the test section (between pressure measurement stations) was 62,812.5 feet. Of this, 147.7 feet was not cleaned in Phase 2, nor coated in Phase 3. Operations were started 65.9 feet downstream of the upstream tap, and completed 81.8 feet upstream of the downstream tap. Thus, the test section presented two different surfaces to the stream. Since this is only .23 percent of the total length, it was not considered important.

4. **Possible error in viscosity.** Viscosity was calculated, not measured. However a fairly large error is necessary to appreciably shift the plots to right or left.

5. **Reduction in diameter.** A calculation of the gallons of coating used shows an average 6 mil thickness. This reduction of diameter theoretically will affect the transmission factor by slightly more than 0.1 percent.

Practical Smooth Pipe Law. The smooth pipe law of Von Karman and the Bureau of Mines states:

$$\sqrt{\frac{1}{f}} = 4 \log (N_R \sqrt{f}) - 0.6 \qquad (19)$$

For practical application, the effect of bends and foreign materials may be taken into account by writing a "practical" smooth pipe law. For extremely smooth pipe in commercial use, the resistance coefficient of equation (19) can be assumed from the results to be approximately 92 percent of the actual resistance coefficient. Thus, a "practical" smooth pipe law:

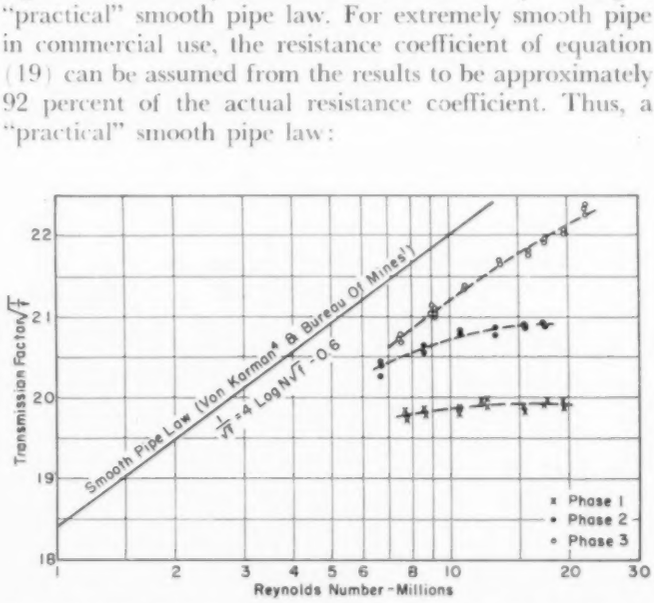


FIGURE 11—Performance of 11.896 miles of 24-inch, 0.250 inch w.t. natural gas pipe line under the following conditions: Phase 1—Line test after 10 years of operation. Phase 2—Line test after cleaning with two wire brush type pigs. Phase 3—Line test after internal coating.

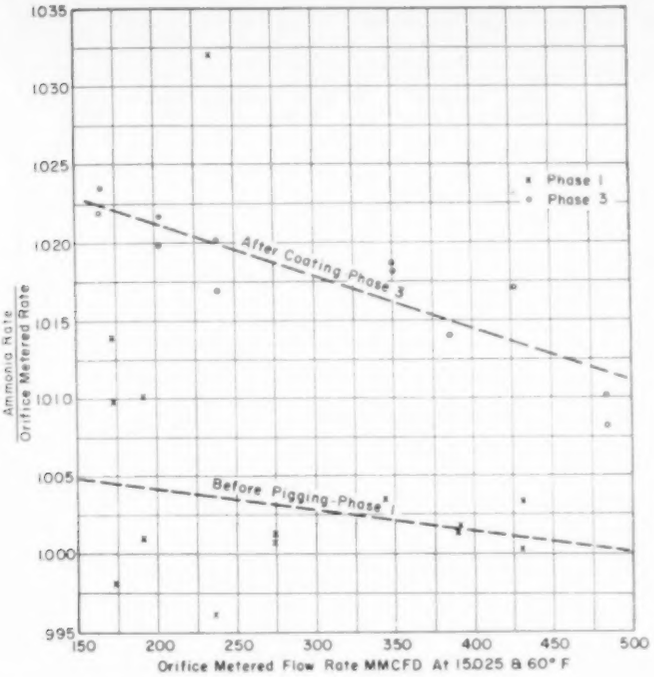


FIGURE 12—Ammonia displacement test calibration compares ammonia flow rate with orifice metered rate.

$$\frac{1}{\sqrt{.92f}} = 4 \log (N_R \sqrt{.92f}) - 0.6 \qquad (20)$$

which reduces to:

$$\sqrt{\frac{1}{f}} = 3.84 \log (N_R \sqrt{f}) - 0.64 \qquad (21)$$

The author suggests that this equation could be used for estimating purposes with more accuracy than equation (19).

Flow Formulas. It is beyond the scope of this paper to discuss the different flow equations. However, as a basis of comparison, Figures 8, 9 and 10 are included in this report to show the effect of the change in roughness and the change in thruput upon the E factor of three of the equations in common usage.

Ammonia Tests. The ammonia injection tests were conducted with equipment and techniques developed by Tennessee Gas engineers in 1953, based upon the initial development of the method by Panhandle Eastern Pipe Line Company.

Figure 12 indicates that the rate of flow calculated by ammonia displacement increases with decrease in roughness. Or stated in another way, the smoother the pipe, the less the travel time of the ammonia. This indicates that the calibration is dependent upon the degree of turbulence.

Gaseous ammonia has approximately the same specific gravity as the gas, and will therefore mix readily and completely at the injection point. In traveling over a distance however, the dispersion of the ammonia is dependent upon distance and the velocity profile. The travel time is some function of the maximum velocity.

The smoother the pipe, the less turbulence, and the velocity profile is more nearly parabolic. As flow or roughness increases, the profile flattens and the maximum velocity approaches the average velocity. From the ammonia calibration graph, therefore, we can conclude that the degree of turbulence for the high rate of flow in Phase 3 is slightly less than that for the low rate in Phase 1. It indicates that Phase 3 is about to begin an abrupt departure from the trend shown in Figure 11. This was the basis used in estimating the 180 microinch figure previously discussed.

From the results, it is reasonable to assume that injections of radio-active materials are subject to the same calibration.

Coating Distribution. Approximately 100 feet of pipe was removed from the test section on April 6, 1959. There was a two wrinkle sag bend in the portion removed.

The interior of the pipe that was removed was examined and found to be completely coated. A depth of 2 inches of dry coating lay in the lowest part of the sag, tapering off to a depth of about one-sixteenth inch where the pipe was straight and more nearly horizontal. The extra thickness of coating was observed over approximately 50 feet of pipe length (see Figure 7).

Probable Cause of Coating Deposition. During the cleaning operations of Phase 2 and the cleaning and coating operations of Phase 3, every pig or plug was temporarily stopped at or near the area in which the pipe was removed. It is possible that this excess coating material was deposited while the plugs were stopped.

Cross-Section Effects. The equivalent length of noncircular cross-section may be obtained in terms of circular cross-section by the following, in consistent dimensional units:

$$L_e = L_a \frac{A_c^2 H_c}{A^2 H}$$

where L_e = Equivalent Length
L_a = Actual Length
A = Cross-Sectional Area
H = Hydraulic Radius
(Subscript c refers to circular cross section)

A 2-inch deposit of material reduces the cross-sectional

TABLE 4—Indications of Gas Quality

Phase	Test No.	Water Content Lbs/Million Cubic Ft.	Hydrocarbon D.P. °F	Pressure PSIA
1	1-A	3.25	51	710
	1-B	4.0	46	705
	1-C	3.85	50	650
	2-A	3.3	44	650
	2-B	4.2	55	640
	2-C	4.75	48	635
	3-A	2.9	44	715
2	1-A	3.9	41	715
	1-B	4.4	44	710
	1-C	4.0	40	700
	2-A	4.2	43	650
	2-B	4.5	42	635
	2-C	6.8	56	635
	2-CR	4.5	50	615
	3-A	3.2	48	705
3	1-A	3.6	38	705
	1-B	4.3	44	700
	1-C	4.4	41	695
	1-AR2	4.7	50	700
	2-A	3.9	41	660
	2-B	...	...	...
	2-C	3.7	39	645
	2-D	3.4	46	635
	3-A	3.9	44	710

Companies participating in the test

Texas Gas Transmission Corp.
Lone Star Gas Co.
Transcontinental Gas Pipe Line Corp.
Humble Oil & Refining Co.
El Paso Natural Gas Co.
Trunkline Gas Co.
Coast Paint and Lacquer Co.
Pipe Cote Service Corp.
Northern Natural Gas Co.
Tennessee Gas Pipeline Co.

area by about 4 percent and adds approximately 12 percent to the equivalent length.

Effect. Thus, if it is assumed that the maximum depth is effective over half the distance of the tapered depth, the deposit of coating adds only 3 feet to the total distance.

A phenomenon was noted in the examination of the pipe interior. The walls of the pipe were "striped" parallel to the flow, with very fine lines of dust deposit. In the section of pipe where there was no additional thickness of coating, these stria were observed around the full circumference. They could easily be wiped clean, exposing a slick surface of coating underneath.

DISCUSSION OF CALCULATION METHODS

Neglecting the change in kinetic energy, the equation for the resistance coefficient for a horizontal pipe line has been expressed[1] as:

$$f = \frac{13780\, T_B^2\, (P_1^2 - P_2^2)\, d_i^5}{Q^2 P_B^2 GTZL} \qquad (1)$$

where f = resistance coefficient, dimensionless
T_B = temperature base, °R
P_B = pressure base, psia
P_1 = initial pressure, psia
P_2 = final pressure, psia
d_i = internal pipe diameter, inches
Q = flow rate, scf/hour, measured at P_B and T_B
G = specific gravity of gas (air = 1.0)
T = average flowing temperature, °R
L = pipe length, feet
Z = average compressibility factor, dimensionless

Weymouth[2] derived essentially the same equation from Unwin,[3] except for dimensions. The main difference is that Weymouth assumed ideal gas laws, hence his equation does not contain the Z term.

The resistance coefficient (f_o) normally used outside the gas industry is calculated by the Darcy-Weisbach equation:

$$f_o = \frac{2gDh}{LV^2} \qquad (2)$$

where g = acceleration due to gravity ft/sec/sec
h = loss, feet of head
V = velocity, feet per second
D = inside diameter of pipe, feet

Equation (1) may also be derived from equation (2), but there will be a difference in the constants. This difference resolves of the fact that the Unwin formula contains hydraulic radius as a term, and the Darcy-Weisbach equation contains pipe diameter. Since the hydraulic radius of a pipe is equal to $d_i/4$, then:

$$f_o = 4f$$

ASSUMPTIONS MADE IN THE CACULATIONS

No Change in Kinetic Energy. The effect of the change in kinetic energy in the larger diameter pipes at economical flow rates is negligible. The maximum effect on the resistance coefficient was only 0.1%.

Isothermal Flow. The test site is located midway betwen two compressor stations that are approximately 90 miles apart. Being 45 miles from the discharge of the first station, the gas had a chance to approach ground temperature, and remain fairly constant. The maximum change between upstream and downstream gas temperatures was only 2.5 °F. for any flow rate.

Constant Compressibility Factor. The maximum variation in compressibility was approximately 1%, occurring at the higher flow rates when there was a large pressure differential.

Correction for Change in Elevation

Letting

$$K = \frac{13780\, T_B^2 d_i^5}{Q^2 P_B^2 GTZ}$$

and restating equation (1)

$$f = \frac{K\,(P_1^2 - P_2^2)}{L} \qquad (3)$$

Then the differential equation, of which (3) is a solution, is:

$$pdp = \frac{fdL}{2K} \qquad (4)$$

A uniform pressure gradient can be assumed without introducing any appreciable error, as long as the flow remains isothermal (or nearly) and the pressure differential (dp) remains a small percentage of P (say, 10% or less). Then (4) may be solved as a difference equation and it can be stated:

$$L = dL \qquad (5)$$

$$P = \frac{P_1 + P_2}{2} \qquad (6)$$

Since equation (1) assumes a horizontal pipe line, dp is the pressure differential resulting from frictional resistance only. The pressure differential resulting from change in elevation must be considered.

Let dp_e = change in pressure due to change in elevation
dp_m = measured change in pressure, $(P_1 - P_2)$

About the Author

C. H. Klohn, engineer in the Planning section of Tennessee Gas' Engineering Department, was active in the several phases of coated pipe flow tests near Refugio, Texas. A civil engineering graduate of Rensselaer Polytechnique Institute, Klohn first joined TGT in 1950; prior to this research project, he had completed assignments in design, construction and operating research. Following graduation from RPI, Klohn worked one year with the Ohio state highway department. He is a registered professional engineer in Ohio.

Then

$$dp = dp_m - dp_e \text{ (The line is gradually sloping uphill)} \quad (7)$$

Substituting (5), (6), and (7) in (4):

$$\left(\frac{P_1 + P_2}{2}\right)(P_1 - P_2 - dp_e) = \frac{fL}{2K} \quad (8)$$

Letting H = the change in elevation (ft) and

W = specific weight lbs/ft^3

$$dp_e = \frac{WH}{144} = \frac{.0763GP\ 520}{144\ TZ\ 14.696}H = .01875\ \frac{GPH}{TZ} \quad (9)$$

Substituting (6) in (9)

$$dp_e = .00938\ GH\left(\frac{P_1 + P_2}{TZ}\right) \quad (10)$$

Substituting (10) in (8) and rearranging:

$$f = (P_1 + P_2)\left(P_1 - P_2 - .00938GH\frac{P_1 + P_2}{TZ}\right)\frac{13780\ T_B{}^2 d_i{}^5}{Q^2 P_B{}^2 GTZL} \quad (11)$$

For use in the calculations of the data in this report:

$T_B = 520\ ^\circ R$
$d_i = 23.5$ inches
$P_B = 15.025$ psia
$L = 62{,}812.5$ ft.
$Q = \frac{1{,}000{,}000\ Q_m}{24}$ (expressing Q_m as MMscfd)
$H = 17.48$ ft.

Substitution of the above constants in (11) results in the final equation:

$$f = \frac{1.0847\ (P_1 + P_2)\left[P_1 - P_2 - .16396G\left(\frac{P_1 + P_2}{TZ}\right)\right]}{Q_m{}^2 GTZ} \quad (12)$$

Correction for Position of Deadweight Gages. The deadweight gages were read on top of the ground, setting on a tripod. Both upstream and downstream pressures were taken at a point approximately 8 feet above the pipe. Hence, the weight of a column of gas one square inch in cross-section and 8 feet high, plus the atmospheric pressure, was added to the deadweighted pressure.

$$P_{1,2} = P_{D.W.} + P_{ATM.} + .150\ \frac{GP_{1,2}}{T_{1,2}Z_{1,2}}$$

Reynolds Number:

$$N_R = \frac{WDV}{M}$$

where W = specific weight lbs/ft.^{3}
D = pipe diameter, ft.
V = velocity, ft./sec.
M = dynamic viscosity, lbs./sec. ft.

$$W = 2.6998\ \frac{GP}{TZ}$$

$$V = \frac{4}{\pi}\ \frac{1{,}000{,}000}{86{,}400}\ \frac{Q_m TZP_B \times 12^2}{d_i{}^2 PT_B}$$

$$V = 2122.1\ \frac{Q_m TZP_B}{d_i{}^2 PT_B}$$

Substituting:

$$N_R = 2.6998\ \frac{GP}{TZ}\left(\frac{2122.1\ Q_m TZP_B}{d_i{}^2 PT_B}\right)\left(\frac{d_i}{12}\right)\Big/ M$$

And:

$$N_R = 477.44\frac{GQ_m P_B}{d_i T_B M} \quad (13)$$

For use in this report:

$P_B = 15.025$ psia
$d_i = 23.5$ inches
$T_B = 520\ ^\circ R$

$$N_R = .587\ \frac{GQ_m}{M} \quad (14)$$

AMMONIA DISPLACEMENT CALCULATIONS

The theory of ammonia displacement is simple. By obtaining pressures, temperatures, gravity and compressibility factors at the upstream and downstream ends of a section of known pipe volume, the standard cubic feet of "stored" gas can be computed by Boyles and Charles laws. Letting V_s = standard cubic feet per unit of length at any point and A = cross-sectional area of pipe:

$$V_s = \frac{P\ T_B}{TZ\ P_B}A \quad (15)$$

Then, by "marking" the upstream end of this calculated quantity, and observing the time required for the mark to travel to the downstream point, a flow rate is established.

The writer has found, from past experience, that displacement tests cannot be conducted over a great distance with a reasonable degree of accuracy. And when tests are conducted where there is a large variation in temperature, the average V_s is subject to considerable error when calculated by means of

$$\frac{P_{avg}}{T_{avg}\ Z_{avg}}.$$

However, if we assume a uniform variation of specific volume over these short distances, the chances for considerable error are minimized.

Then:

$$V_{s_{avg}} = \frac{V_{s_1} + V_{s_2}}{2} = \frac{T_B\ A}{2\ P_B}\left(\frac{P_1}{T_1 Z_1} + \frac{P_2}{T_2 Z_2}\right) \quad (16)$$

If

T = travel time, minutes

$$V_{s_{avg}} = \frac{Q_m \times 10^6\ T}{1440\ L}$$

Then:

$$\frac{Q_m \times 10^6\ T}{1440\ L} = \frac{T_B\ \pi\ d_i{}^2}{2P_B 4 \times 144}\left(\frac{P_1}{T_1 Z_1} + \frac{P_2}{T_2 Z_2}\right)$$

And:

$$Q_m = \frac{3.927\ T_B\ d_i{}^2\ L}{T\ P_B \times 10^6}\left(\frac{P_1}{T_1 Z_1} + \frac{P^2}{T_2 Z_2}\right) \quad (17)$$

For use in this report:

$L = 62812.5$ ft.
$d_i = 23.5$ inches
$T_B = 520\ ^\circ R$
$P_B = 15\ 025$ psia

$$Q_m = \frac{4714.5}{T}\left(\frac{P_1}{T_1 Z_1} + \frac{P_2}{T_2 Z_2}\right) \quad (18)$$

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ACKNOWLEDGMENT

This project was made possible by the joint efforts of many of the personnel of the contributing organizations. Special credit is due to the pipe line, compressor and measurement personnel of Districts 1 and 9 of Tennessee Gas Pipeline system.

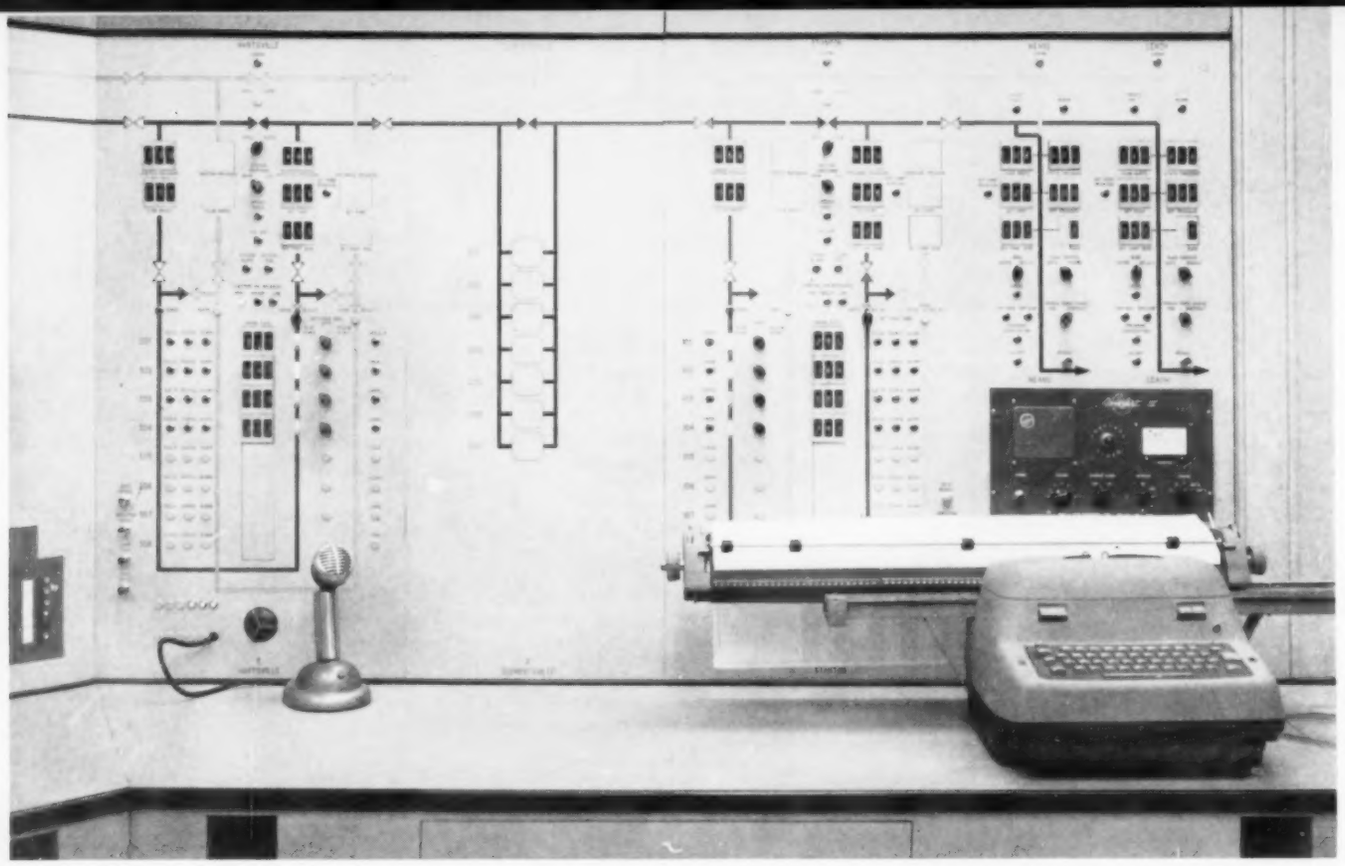


FIGURE 1—Integrated centralized control console on Columbia Gulf Transmission Company. The line controlled from this installation is 800 miles long. Digital indicators are used to obtain accurate data from field locations at desired intervals.

How Fully Integrated Control Systems Work

Remote controls with fully integrated centralized computer are both practical and available

By William F. Haley, Union Switch & Signal Division, Westinghouse Air Brake Co., Swissvale, Penn.

THE DEFINITE MOVEMENT toward centralized control by major pipe line companies in recent years has resulted in a new wave of progressive thought regarding the over-all systems concept. From the skeptical outlook of a few years back, many pipeliners, caught up in the great wave of technological progress, have had an about face in thinking along these lines. After all, if it is possible to place a missile in orbit around the sun, it shouldn't be too difficult to make a pipe line completely automatic.

True. Yet there are rigorous standards of design that must be followed if a successful system is to be installed at the present time. A computer is no better than the data fed into it and a control system is no better than the worst boo-boo it can make.

Objectives of a Control System. Two terms often linked together today, are *remote control* and *digital telemetering*. The latter is defined as a system utilizing equipment which instantly converts the value of each operating variable into binary digits. These variables may include flow, suction pressure, discharge pressure, and engine speeds. All pertinent data are transmitted to the controlling station in this digital form when values change. Upon receipt at the control center, this information is decoded and displayed on the console, or logged in a typewritten line, or punched on tape for future use by the pipe line company.

It is at this stage in pipe line control that the elements involved in remote control and digital telemetering are combined with other available elements to form a truly centralized

operation. Such a control system is comprised of the following technological elements:

1. Remote or supervisory control
2. Telemetering—digital or analog
3. Communications
4. Sequence or automatic control of remotely located controlled equipment
5. Instrumentation including primary measurement equipment, necessary feedback or control loops and function control elements
6. Data handling—including acquisition and field monitoring
7. Computing equipment, data conversion and decision type
8. Integration of data into accounting operations.

The objectives of a centralized control system, can be explained more fully by examining Figure 2. Two types of codes are presented in diagram form to show the code structure by a series of marks and spaces which total 24 steps.

The base line of the illustrated code is a reference to time, and the vertical line represents a break in the electrical circuit. It might be understood more easily by imagining a wire being continuously energized and then alternately interrupted at two different time intervals. It must be noted that the communication facility is energized at all times in order to keep a constant check on circuit continuity.

If the circuit drops to space for more than one second, the coding equipment will recognize a communication fault and ring an alarm at the controlling station. Each code is made up of 12 marks and 12 spaces, totalling 24 steps. The marks and spaces can be characterized to contain information by lengthening a step to approximately three times that of a non-characterized step.

The lower portions of Fig. 2 is a code structure transmitted from the office to a field station or many field stations. This is identified by Step 1 dropping to space longer than any other step in the code. Step 1 will always be longer in a control code so as to give the coding equipment a control-code priority and to indicate to the office coding unit that it is transmitting. Thus, all field coding units shall receive data and not interrupt transmission. The Steps numbered 2 through 8 are comprised of seven steps for address selection. Steps 4, 5 and 7 of this particular code are characterized, indicating to one field coding unit that the following information is to be registered.

All Relay Design. More often than not, a centralized control system features an all-relay design. An integral part of such an all-relay system is the coding transceiver. It performs the function of characterizing each code message into a fixed number of periods of time—called steps—during which energy is alternately applied to and removed from the transmission circuit. These time periods are comprised of a variable number of long and short steps, depending on the information to be transmitted.

By pressing a selected pushbutton on the control panel, a code is automatically characterized which will key the coding unit. A receiver at the field station will repeat the code and operate the proper circuitry to perform the desired function. Conversely, a similar circuit operation takes place when an indication code is transmitted to the office. These indication codes will be initiated as a change occurs at a field station, or on demand from the controlling station.

Address Capacity. In an integrated multiple-station control system, it is possible to maintain a 35-address capacity. The control address permits five three-position controls per address which amount to a total of 175 three-position controls. The indication address permits 15 lamp indications per address, or four three-digit data quantities per address. The 35-address can be spread to cover any number of field stations. Addresses are added in modular form when the need arises for future information.

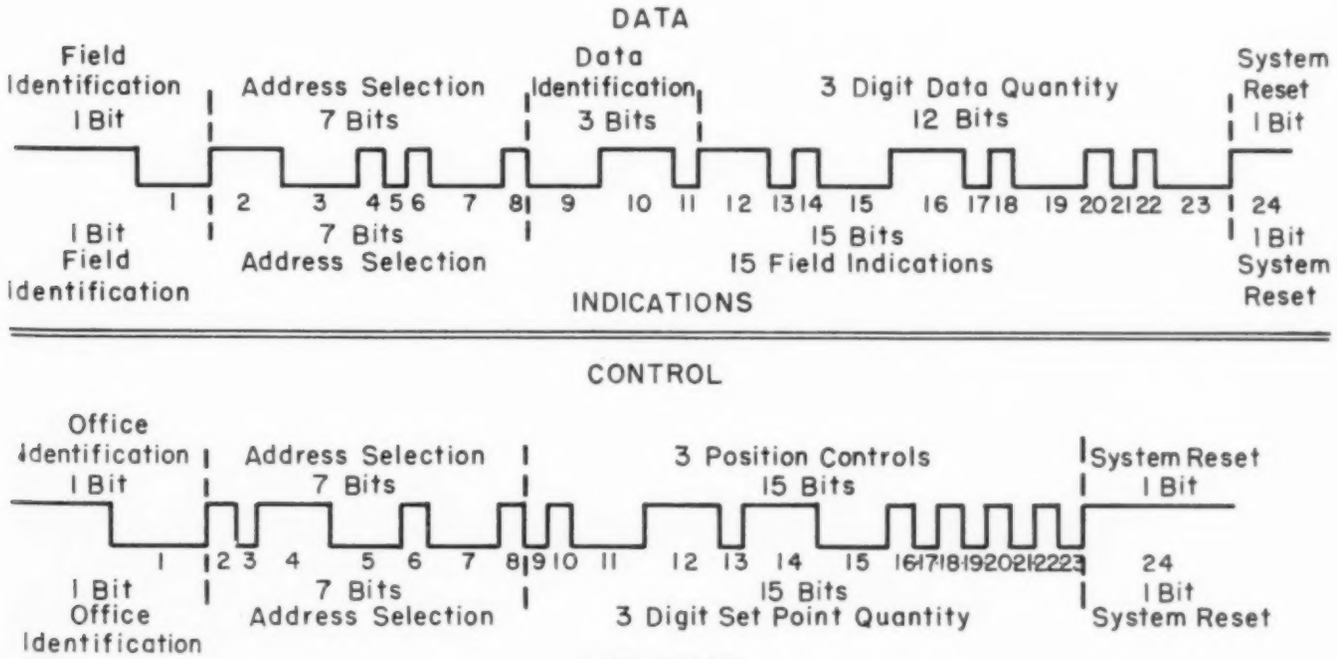

DATA
Field Identification 1 Bit
Address Selection 7 Bits
Data Identification 3 Bits
3 Digit Data Quantity 12 Bits
System Reset 1 Bit
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
1 Bit Field Identification
7 Bits Address Selection
15 Bits 15 Field Indications
1 Bit System Reset
INDICATIONS
CONTROL
Office Identification 1 Bit
Address Selection 7 Bits
3 Position Controls 15 Bits
System Reset 1 Bit
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
1 Bit Office Identification
7 Bits Address Selection
15 Bits 3 Digit Set Point Quantity
1 Bit System Reset
SET POINT

FIGURE 2—The base line in this code is in reference to time. The vertical lines represent breaks in the electrical circuit. Step 1 is long or short to indicate the office or field. Steps 2 through 8 are used for 35 indication address combinations, and Steps 9 through 23 may be used to transmit numerical values, etc. Step 24 simply converts all coding equipment to monitor-receive position.

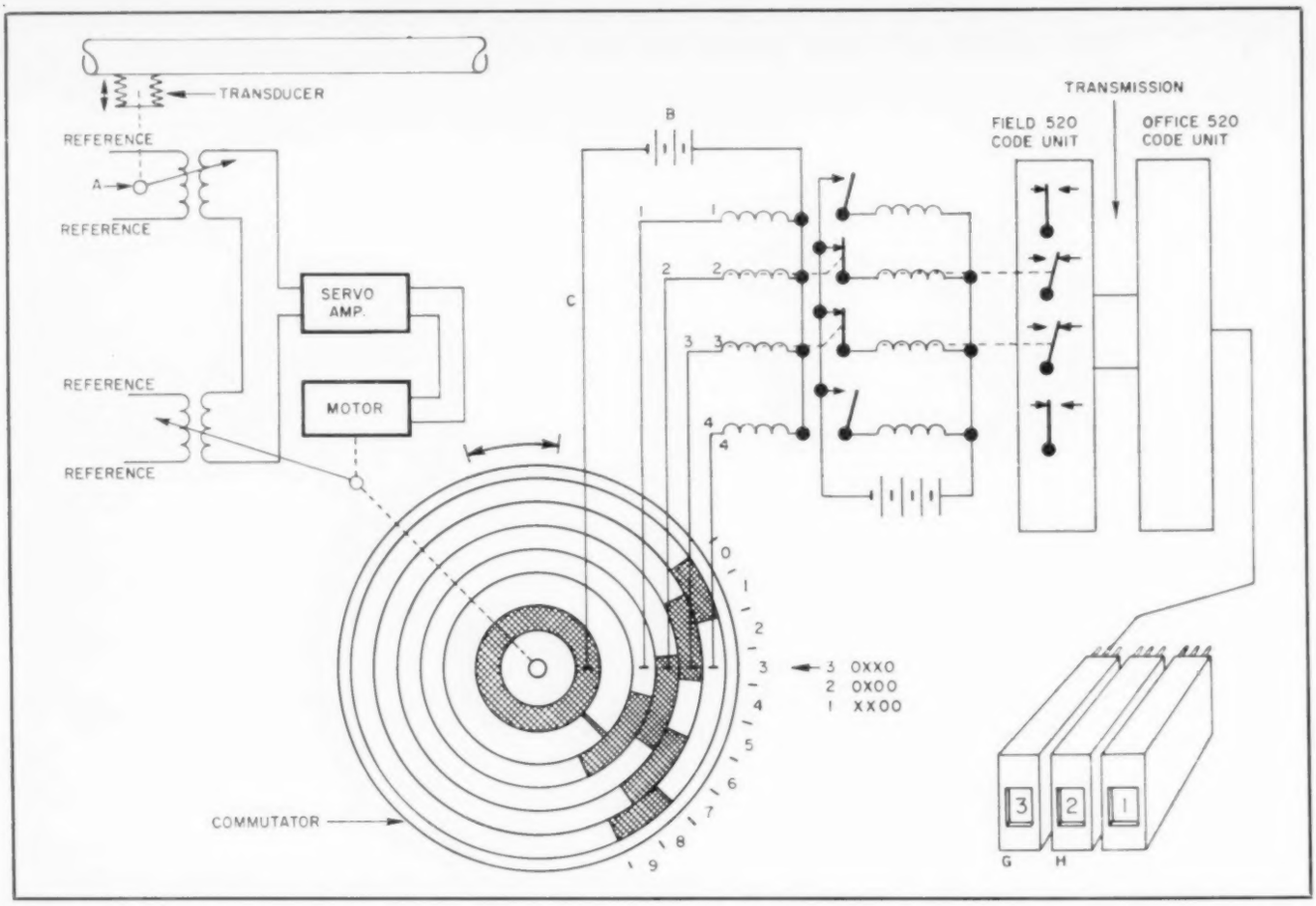
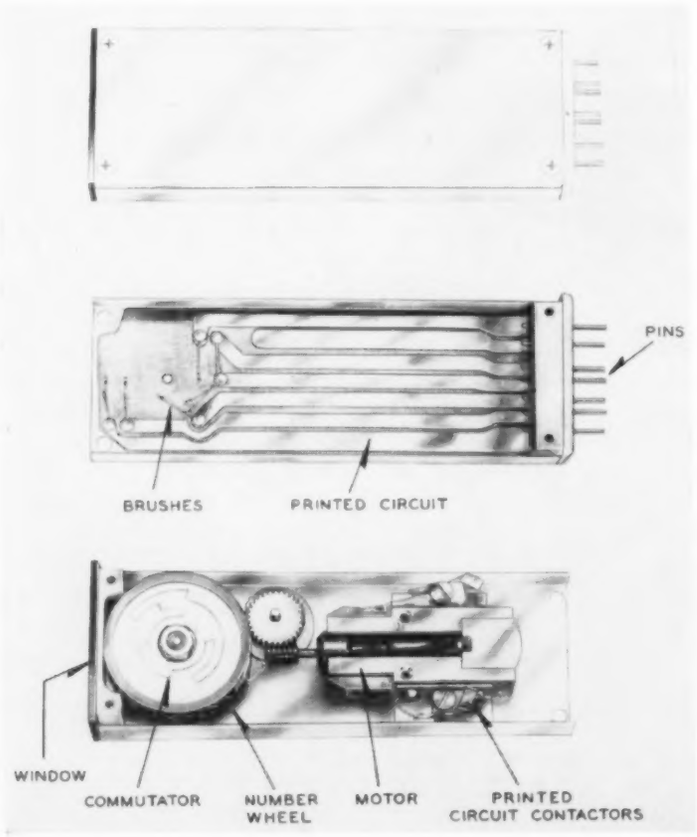


FIGURE 3—How data is acquired and transmitted. This servo instrument has a transducer input from a differential transformer or strain gage. The output of the transducer is on one side of the bridge, and a slide wire driven by a null and balance servo is on the other side. Changes position the commutator which, in turn, transmits this information to the code unit.



How the System Works. Rearranging the characterized steps in relation to the short steps will permit 35 different combinations, or 35 address selections. Steps 9 through 23, comprising 15 steps, will permit five three-position controls to be delivered with that particular address selection. One three-position control could Start-Stop-Reset a field unit or Raise-Lower-Stop a field controller or Open-Close-Stop a station or regulator valve. Step 24 will bring the communication circuit back to mark and reset all coding units to the monitor-receive position.

Example. If a dispatcher desires to send a data quantity from the office to one of the field stations to control a set-point controller to an exact three digit pressure setting, he may do so by characterizing Steps 9 through 23 in a 1-2-4-8 binary code. Steps 9, 10,

FIGURE 4—Digital indicator. This small electro-mechanical storage device has a printed circuit, six brushes and a motor driven commutator.

11 and 12 would be used to obtain the units digit. Steps 13, 14, 15 and 16 would be utilized for the tens digit; and Steps 17, 18, 19 and 20, for the hundreds digit.

At the top of Figure 2 is a code structure with Step 1 being short to indicate that one field station is transmitting. Steps 2 through 8 are again used for a thirty-five indication address combination. Steps 9 through 23 will permit fifteen field alarm and status indications in the form of lighted indicator lamps in the office. Again, Step 24 converts all coding equipment to the monitor-receive position. The centralized control equipment in the field has built-in intelligence to report a status change of any monitored function.

Data acquisition can be accomplished in the field in several different ways. One of the most commonly used methods is a servo instrument with a transducer input from a differential transformer or a strain-gage. See Fig. 3. The output of the transducer is in one side of a bridge; and a slide wire, which is driven by the null and balance servo, is in the other side. As the pipeline pressure at the measured point changes, it unbalances the servo and creates an output that repositions it until the amplifier output returns to null. An encoder which converts analog pressure to digital form is mounted on the same shaft that positions the read-out pointer on the indicator. The encoder is a commutating device with a four-wire brush output per digit.

How Is This Information Transmitted to the Office? First, it is necessary to explain what is meant by a 1-2-4-8 binary code and how it operates. To obtain a reading of a digit from 0 to 9, a four-wire input is necessary. These four wires are designated wire one, wire two, wire four and wire 8. If wire 1 is energized, the encoder indicates the number 1. If wire 2 is energized, it indicates the number 2; and if wire 1 and 2 are energized, it indicates the number 3. Thus, by energizing any combinations of wires 1-2-4 or 8, it is possible to obtain sixteen different combinations. In this case we are interested only in combinations from 0 to 9.

By monitoring the variations of the measured variables (pressure, flow etc.) in the field it is possible to monitor pressure changes varying from 2.5 pounds to 25 pounds. This change monitor will provide the field coding equipment with intelligence to report data on such changes. This will enable digital data quantities to be displayed on an office panel on a continuous basis.

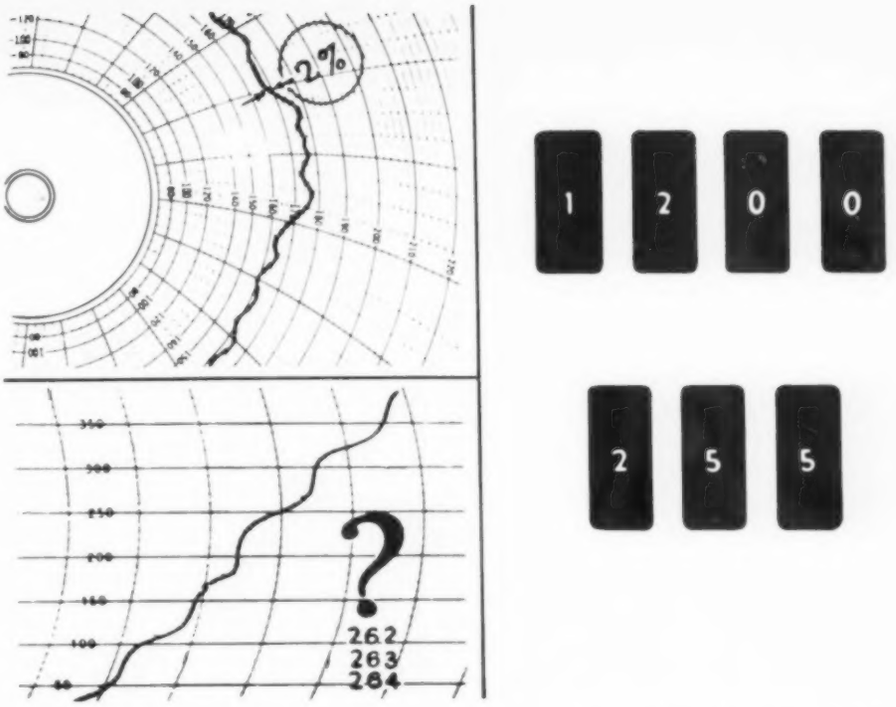


FIGURE 5—A comparison between digital readout and a graphic readout. Circuit failure can cause large errors in an analog system. A digital system will not accept distorted codes.

Transmitting data. Referring to the top half of Figure 2, we find that data can be transmitted easily over this code structure. If Step 1 again indicates that a field coding unit is transmitting, and if Steps 2 to 8 indicate one out of a possible 35 addresses, it can be seen that Steps 9 to 11 will provide a data identification combination made-up of a maximum of four selections. Steps 12 through 23 provide the twelve bits which are necessary to report a three-digit data quantity in a range from 0 to 999. Referring to the 1-2-4-8 binary code, Steps 12, 13, 14 and 15 are assigned correspondingly to it. Long Steps 12 and 15 indicate wire 1 and wire 8 will become energized to read-out the number 9 at the receiving point. Steps 16, 17, 18 and 19 would indicate a figure 9 for the tens figure, and Steps 20, 21, 22 and 23 would indicate the number 8 in the hundreds column. The figure transmitted by this code would be 899.

Electro-Mechanical Storage Devices. At the receiving office station, the code can be delivered to different types of indicating devices. One most commonly used is a small electro-mechanical storage device called a

FIGURE 6—Comparison of analog and digital system accuracies expressed in percent of full range values.

COMPARISON TABLE

DESCRIPTION	Range	Analog Accuracy	Digital Accuracy
Discharge Pressure Transducer	0–1000 PSIG	± .25%	± .25%
Discharge Pressure Recorder	500–1000 PSIG	± .25%	± .25%
Converting from Shaft Position to Telemetering Code	500–1000 PSIG	±1.0%	± .1%
Telemeter Transmitter and Receiver	500–1000 PSIG	±1.0%	±0.0%
Pressure Indication	500–1000 PSIG	± .5%	±0.0%
		3%	.6%

digital indicator. This indicator is shown in Figure 4. The operation of the digital indicator is based on a positioning system utilizing the four-bit binary code. Ten character-positions of a possible sixteen are used. The relation of the visible character to its code for the standard digital indicator is the direct electro-mechanical conversion of a binary signal to a decimal readout.

A single commutator is used in this indicator. A total of six brushes are used, four of which make selective contact in combination to either the plug battery slip ring or the motor circuit slip ring. The indicator is internally powered by a small D.C. permanent magnet motor.

A mismatch between a transmitted code and that commutated by the indicator will complete the circuit causing the motor to operate. The commutator is driven by the motor until the transmitted and commutated codes coincide. At this instant, the motor is deenergized and the indicator comes to rest, displaying the character whose code was transmitted.

After the digital indicator is positioned, it retains the information indefinitely, visually and electrically, until a new code is transmitted to the indicator. The use of this indicator enables a person to obtain an exact reading without having to interpret a curve or pointer on a scale. Figure 5 shows the comparison between digital readout and a graphic readout. The comparison table reveals some of the discrepancies expressed in percent full range value.

Errors. It is quite possible to have errors in an analog system up to several hundred percent as a result of a communication circuit failure or the injection of noise. In a digital system, a distorted code will not be accepted by the coding equipment because of built-in levels of security. The centralized control system will reject distorted codes and will automatically ask the transmitting station to repeat its information until it is acceptable. Meanwhile, the data display remains at a constant value until an accepted code is delivered.

Figure 5 graphically illustrates that a line inked onto a revolving chart requires interpolation, which often causes a small percentage of error due to human judgment. Similarly, a line drawn in ink across the surface of a graph is subject to the same human judgment error. It may be a case of a dispatcher deciding whether the number involved is 262, 263 or 264. The element of human error is eliminated automatically when digital indicators are employed in a system. A specific number is always readout at the receiving station or control console.

Accuracy. The complete system accuracy can be better explained by the examination of Figure 5 which compares a particular value brought into the office by means of an analog method rather than via digital means. Note that the transmitting and receiving equipment will guarantee a pressure reading to be transmitted and displayed without error. The only error in the system is developed in the analog to digital translation in the field.

In a centralized control system where the data is brought in and displayed digitally, it is possible to use data handling equipment with a minimum amount of expense. By the addition of a programmer and digital clock, a logger can be utilized in the system to keep a permanent record of the status of the entire pipe line. A set of selector switches can be provided in the office which will enable a dispatcher to choose a logging cycle that he might require.

The logger could print out information every minute, every thirty minutes, or on the hour, as desired. By using a centralized control system a print-out can be initiated by an upset and accumulation monitor. This equipment is mounted in the field to continuously watch each data reading and report it in event of an upset. The upset range can be adjusted so that an alarm upset condition will be reported when the pressure deviates beyond a prescribed limit.

When the upset code is received in the office, the logger will automatically print the time in red showing that this printout is not on a prescribed time interval. All data will be printed in black except the data quantity or quantities which were reported as upset. Again, these are printed in red. The same programmer can be used for punching a teletype tape enabling the data to be transmitted to another location. This system can be readily adapted to punchcards for billing purposes.

A flow reading in digital form can easily be fed into a flow integrator. The flow integrator will integrate flow rate against time and, at any time during a 24-hour period, will display the total flow that has passed through the

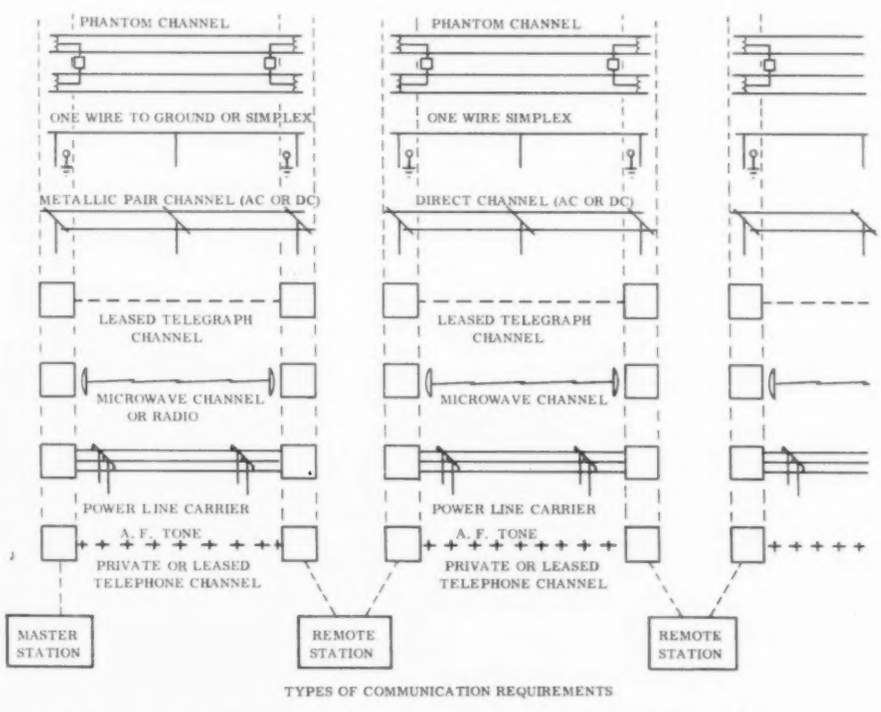


FIGURE 7—Types of communications facilities which are available for use with a centralized control system.

orifice. The flow integrator can be furnished with a predicted flow for a 24-hour period. This equipment will take the present flow, compare it with the present flow-rate, and will display a predicted flow quantity at the end of the day.

Trend Reporter. Another available piece of hardware is a trend reporter that can be adapted to this system. This could be a multiple channel recorder or a single channel furnished with a selector switch to watch trends on any pressure.

Security. The integrated centralized control system requires that a great deal of security and reliability be built into the equipment. System security has to do with the safeguarding of the information entrusted to the system, and the prevention of degradation or falsification of that information. In order to achieve complete security, the system must have sufficient 'intelligence' (in the form of self-monitoring circuits, noise recognition circuits, etc.) to recognize and protect against:

1. Noise and interruption in the transmission medium.
2. Failure in the operation units.

In the second of these, many techniques are required to actually protect against failure. These techniques include the following:

1. Storage of data until it is transmitted correctly.
2. Checking of data to determine if it is correct and not distorted.
3. Employing fail-safe circuits which will not initiate operations due to a system failure.
4. Incorporating a rigorous system discipline to prevent mutual interference.

Reliability. Another important factor in centralized control is reliability. System reliability is the assurance that a system will continue to operate without maintenance. This reliability is directly proportional to the life of the components and the freedom from the possibility of intermittent failures due to certain unpredictable reactions resulting from any of several inherent or environmental causes. Perhaps it would be wise at this time to state that by 'inherent' is meant the lack of constancy of operating characteristics. This includes fatigue of components, which results in a variation in characteristics during its lifetime. 'Environmental' causes included ambient temperatures voltage fluctuations from pressure and humidity.

All of this tends to indicate that the better the quality of the component, the higher the figure of merit for system reliability. And the higher the figure of merit for reliability, the lower the annual cost of maintaining the system.

It is absolutely imperative that a centralized control system maintain a high degree of security during operation. This can be accomplished with relative ease if built-in levels of security are utilized with centralized control equipment. Eleven such levels of security are generally associated with this type of equipment. They are as follows:

1. System is normally quiescent.
2. Communication circuits are continually monitored.
3. Noise injection will not initiate transmission.
4. Noise will not be recognized as information.
5. A signal is inherently different from a noise pattern.
6. Selections are encoded into a parity code so that only a correct selection code can be registered.
7. Control information is encoded for transmission into a self-checking code.
8. Undercount and overcount are monitored.
9. Short-short detection is accomplished to catch distortions of a signal.
10. Simultaneous feed back is guaranteed.
11. Final delivery is accomplished.

As far as the communications spectrum is concerned, it is possible to operate an integrated centralized control system over a wide variety of facilities. These include D.C. line pair, a simplex or phantom circuit, carrier impressed on physical wire, or carrier imposed on telephone company lines. A preferred method, and one of the most economical, is the use of a 0-15 cps half-duplex, telegraph-grade circuit. Figure 7 shows the types of communications facilities which are available for use with a centralized control system.

As stated in the beginning of the article, there has been a definite movement toward centralized system control in the pipe line industry in recent years. There has been much conjecture as to where the trends will lead in the near future. It can be said with certainty that the integrated centralized control system is with us today. It follows that complete automation is the next goal. However, automation as such, is a reality today. The world's first pushbutton gas pipe line is operating successfully and others will soon follow. The hardware for completely integrating systems operation is available, and a delay in accepting the philosophy of integrated operations will only result in expensive redesign and rebuilding programs later on. Utilizing available equipment and modern philosophies today will ultimately result in reduced operating costs, less maintenance, and more efficient pipe line operation.

In conclusion, a few words are necessary regarding the use of computers in integrated systems. It must be remembered that computers are no better than the data fed into them. Before an attempt is made to integrate a computer into a centralized operation, a company must be certain that the data acquisition philosophy is sound, the techniques are accurate and security-bound, and that the hardware is completely reliable.

—The End

About the Author

William F. Haley attended University of Pittsburgh's School of Electrical Engineering and after a period with the armed forces, joined Union Switch & Signal in 1952. His first job was in the Simulator Engineering department working on Flight Simulators for the Air Force program. By 1957 he had advanced to the Systems Design Group. Today he is concerned with pipe line applications of systems control. Haley is a licensed radio operator.

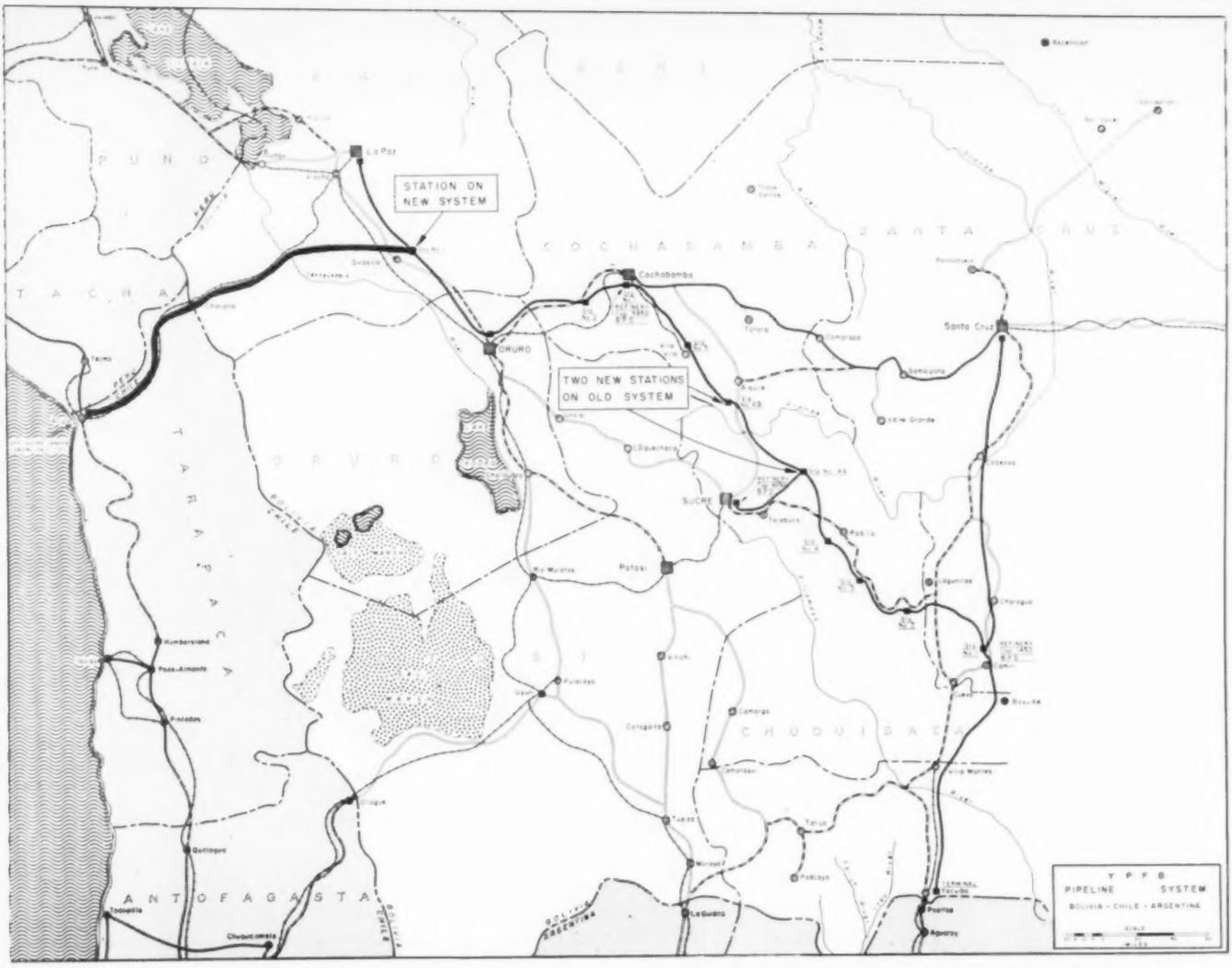


FIGURE 1—Map of the Bolivian pipe line system. The 215 mile line from Sicasica to Arica is a triumph in engineering and construction know-how. In addition, the two-country pipe line represents an intelligent solution to an international problem.

Bolivian Line Extends Across Andes to Pacific Port

One of the world's highest and steepest pipe lines. It descends sharply from an elevation of 14,531 feet to sea level in about 80 miles. Over-all static head—4,792 psi!

By E. E. Mincheff, Senior Engineer
Williams Brothers Company, Tulsa

SICASICA TO ARICA! This 215-mile line now makes it possible for Bolivia —an inland country—to reach world markets with its excess crude via a Pacific seaport in Chile.

In addition to crossing the awesome Andes Mountains at a peak elevation of 14,531 feet and descending from this height to sea level in about 80 miles, the new pipe line has one very remarkable feature. It is the result of cooperation between two countries.

Yacimientos Petroliferos Fiscales Bolivianos, a government entity in Bolivia, has embarked on a program of world trade and today, it can start oil from the Camiri fields on a 709-mile journey to the sea across the great Alto Plano area and across the Andes to Chile's northernmost port. The first 494 miles of this journey is through an existing system to the Sicasica pump station about 65 miles southeast of La Paz. At Sicasica, the crude enters a 215-mile line and travels across a skyline route to the Pa-

the Ocean at Arica, Chile. In the 81-mile downhill slope on the Chilean end of the line, the oil will pass through four pressure reducing stations before entering the terminal tankage. From the terminal it will be pumped into tankers through an offshore tanker loading system.

The capacity of the system has been set initially at 7,000 bpd, but with increased horsepower and additional pump stations, the capacity can be increased to 50,000 bpd.

Concomitant with construction of the new pipe line, the capacity of the Camiri-Cochabamba section of the 494-mile pipe line supplying the new line was increased to 13,000 bpd by the addition of two pump stations and added horsepower at five existing stations. See Figure 1. The new pipe line system and the facilities added to the existing system, were placed in operation in November 1958. Design and construction was by Williams Brothers Company.

Altitude Affects Personnel and Equipment. The new line is not only one of the highest pipe lines in existence, it is one of the steepest. It descends sharply from an elevation of 14,351 feet to sea level with a potential static head greater than any known pipe line system (See Figure 2). Both of these factors introduced unusual engineering and construction problems that had to be considered in designing and building the system. The rarified atmosphere at the high altitudes had to be compensated for in the selection and performance of prime movers, air compressors, air cooled heat exchangers and of course, the mobile construction equipment.

About 185 miles of the pipe line was constructed at an altitude exceeding 12,350 feet. In spite of the axle deep sand, stinging sandstorms, adverse topography of the terrain, drastic winter conditions of the Alto Plano and debilitating effects of altitude on the men, constructors maintained a high spread efficiency. The number of 40-foot joints of pipe laid per working day by the single spread averaged above 360, reaching a maximum of 420 joints for one day.

High altitude vs. men. The only persons not adversely affected by working at the high altitude were the natives of the Alto Plano who have the ability to live and work at normal capacity in the rarified air. The expatriate construction crew lost from 10 to 30 pounds each in the first three weeks of construction. Most of the men went through sleepless nights and severe headaches for the first two or three days in camp. All of the men experienced periods of lightheadedness and shortness of breath until they had learned to adjust their physical efforts to lower extremes than when working in normal environs.

Transportation. Because of limited accessibility to the pipe line right-of-way, the construction men were quartered in camps made up of leased railroad cars parked on sidings at the nearest railroad stations. Transportation was usually afforded by two small gasoline engine-driven autoferries that were permitted to travel between Arica and La Paz on the Bolivian railroad system.

High Altitude vs. Equipment. Special attention was given to the purchasing of construction equipment

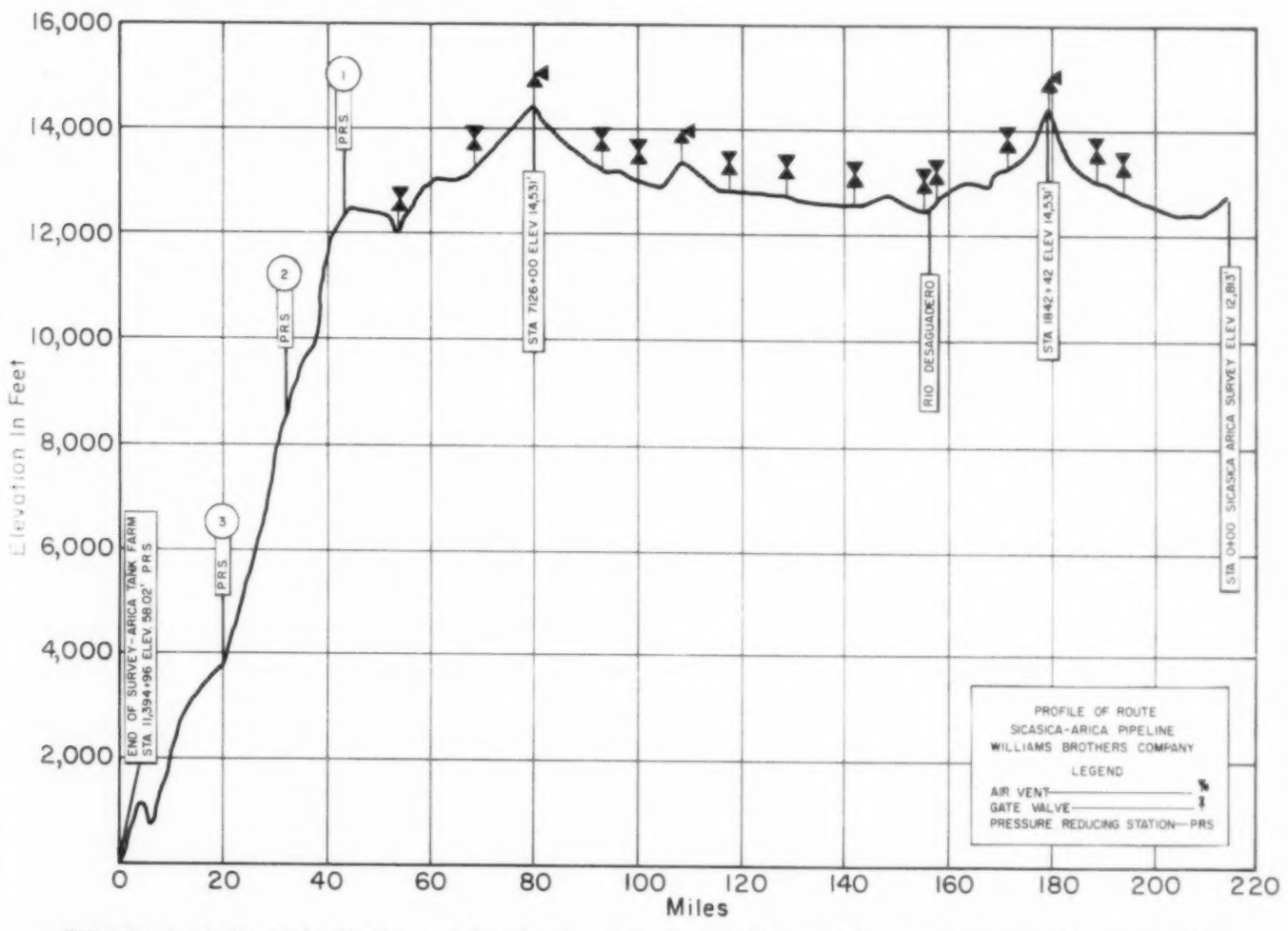


FIGURE 2—Profile of the Sicasica to Arica pipe line. Note that the line peaks in two places at 14,531 feet elevation.

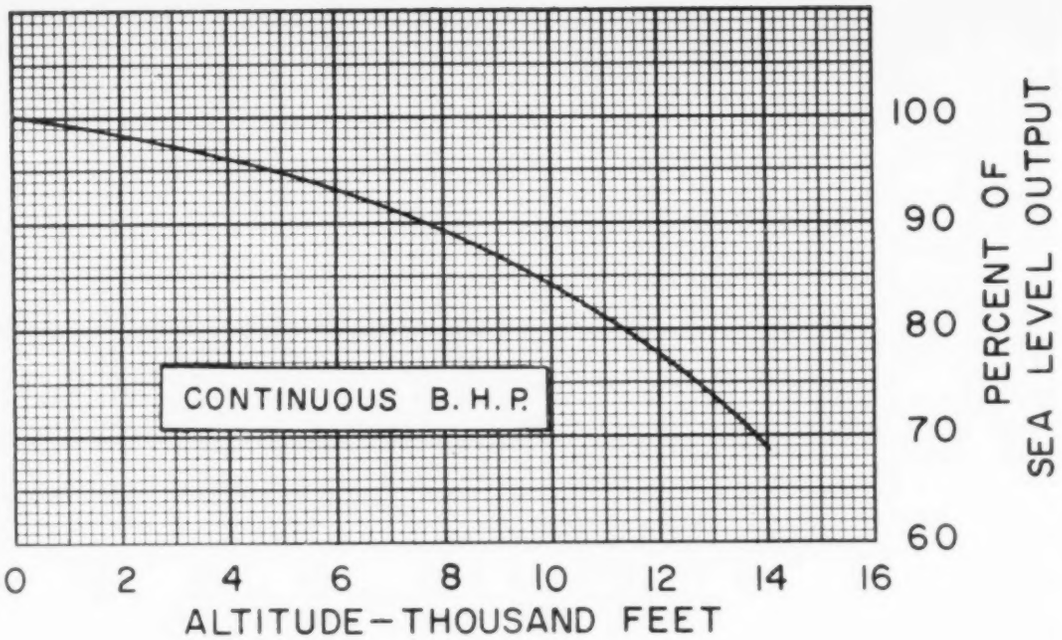


FIGURE 3—The effect of altitudes on men and machines is severe in the extreme altitudes. Note that at 14,000 feet—and the line exceeded this in two areas—diesel engines must be derated to 69 percent efficiency. With an atmospheric pressure of only 8.6 psi absolute, pipeliners from the U.S. find the going tough. The natives, however, can work efficiently in the rarefied atmosphere.

suitable for use at the high altitudes. High altitude carburetor jets, high altitude carburetors, low compression heads, four-wheel drives, and front end winches where applicable were specified. Mobile air compressors were also derated for the effects of altitude. Though the horsepower developed by standard diesel driven equipment was derated to 70 percent of the sea level rating, no special accessories were purchased to compensate for the altitude effects. Engines for pump units, camp generators and mobile air compressors were derated for the operating altitudes. See Figure 3.

Foreign Mills Manufacture Pipe. The new pipe line originates at Sicasica station and consists of 171 miles of 10¾-inch OD, 0.279-inch wall pipe connecting into 44 miles of 8⅝-inch OD, 0.250-inch wall pipe at the Chilean end. Dalmine S.P.A. of Apuania, Italy, furnished 97 miles of 10-inch pipe and Phoenix-Rheinrohr, A.G., Dusseldorf, Germany, furnished 74 miles of 10-inch pipe. All of the 8-inch pipe was furnished by Dalmine SAFTA, Argentina. The 10-inch and 8-inch pipe was manufactured in accordance with API Standard 5LX, Grade X-42, and was mill inspected prior to shipment.

Pressure Reducing Stations Feature Unusual Design. Ambient temperature swings effect large pressure variations in the pipe line during either static or flow conditions. Coexistent with this problem was the necessity for coping with the continuous 14,351-foot static head.

To overcome these problems four self-regulating, automatic, unattended control stations have been installed. They reduce the static pressures into increments that will not over-pressure the pipe. These stations are operated solely by hydraulic pressure from within the pipe line. The individual control components are not new nor unusual in principle, but their combination into a single control system is unique.

The stations are simple, inexpensive and should require a minimum of maintenance. Three of them are on the main line and one is at the terminal. Figures A and B illustrate schematically the control system employed at the three main line pressure control stations.

The control valves at each station are 2-inch, double ported valves with standard bodies, seats and plugs conforming to 900# ASA Standards. However, the diaphragm heads have been modified to operate at the high pressures required. The valve plugs are made from Type 440 stainless steel and the seat rings are stellite faced. In addition, the excess flow valve has been modified to accommodate a self-mounted rate of closure device. The device utilizes the bottom guide of the valve plug as a piston to force oil through a restricting orifice.

Each control station will perform the following functions.

- The pressure reducing valve will maintain 40 psi in the station discharge header during either flow or shut down conditions. In essence, this valve is the crucial element in reducing static head to allowable working pressures in the downstream pipe line section.
- The back pressure valve will relieve upstream header pressures in excess of 110 percent of normal static head. The product passing through these valves enters the downstream header. This valve protects the upstream pipe section during the shut down condition.
- The excess flow valve will cut off pipe line flow if the rate through the station exceeds 110 percent of the established design rate. The purpose of this valve is to shut down the pipe line system in the event of a line break to minimize liquid loss.
- The weight loaded safety relief valve upstream of the station block valve will relieve pressures in excess of 1,650 psi to prevent rupture of the pipe line in the event of human error resulting in block valve closure during repair or maintenance. Oil relieved by this valve is piped to natural drainage.

Whenever the excess flow valve trips and closes, it will be necessary to send a man to the control station to determine the cause of the trouble and to manually reset the valve. Since this item was installed to operate whenever line breaks or large ruptures occur, its actuation will imply trouble requiring field investigation,

so the manual reset was incorporated as a desirable feature for pipe line safety.

To prevent the gravity head from emptying the line on the downhill portion of the system, a hydraulic, pilot-operated, flow control valve has been installed in the low pressure portion of the receiving manifold at the Arica terminal. It may be set at a definite rate of flow and will limit the output of the pipe line to its specific setting.

Capacities. All of the control valves have adjustable features that will handle capacities up to 35,000 bpd. The only change-out feature required at each station will be larger bore orifice plates for excess flow valve control. Above 35,000 bpd, the control valve trim must be changed to a larger size allowing throughputs up to 50,000 bpd which is the maximum design capacity of the line.

Sicasica Station. At the Sicasica pumping station either one of two reciprocating pumps, V-belt driven by diesel engines, will relay the crude oil stream to the Arica terminal. The pump and engine units are equipped with high discharge pressure and low suction pressure switches that will activate a solenoid shutting down the pump units whenever their limiting values are exceeded. Engine speed is controlled by air actuated governors with control air regulated by a recording pressure controller from either station suction or discharge pressure.

Station electric power is furnished by two 30 KW generators direct driven by diesel engines. The two generators may be operated in parallel for maximum capacity. Pumps and generators are housed in a prefabricated asbestos siding-covered steel frame building.

Altitude problems. The elevation of the station is 12,813 feet, requiring that the diesel engines be derated to 70 percent of their sea level horsepower rating. The station air compressors were also derated to supply minimum requirements for the air starting system on the diesel engines. Electric motors and generators, as well as air cooled heated exchangers, were rated to compensate for reduced cooling capacity of rarefied air.

Arica Terminal. The City of Arica is located directly on the Pacific Ocean and its port lies in a cove partially protected from prevailing southwestern winds by a high bluff called El Morro. The sea berth for tanker loading lies outside the protected zone afforded by the bluff and is therefore subjected to the direct effects of ocean breezes.

Weather conditions at Arica might be termed ideal. Temperatures are moderate year around, varying between 55 and 78° F. For the last 16 years no rainfall of measurable proportions has been recorded at Arica. However, to offset this ideal situation, the area is subjected to frequent earthquake tremors with some shocks of considerable magnitude. Almost

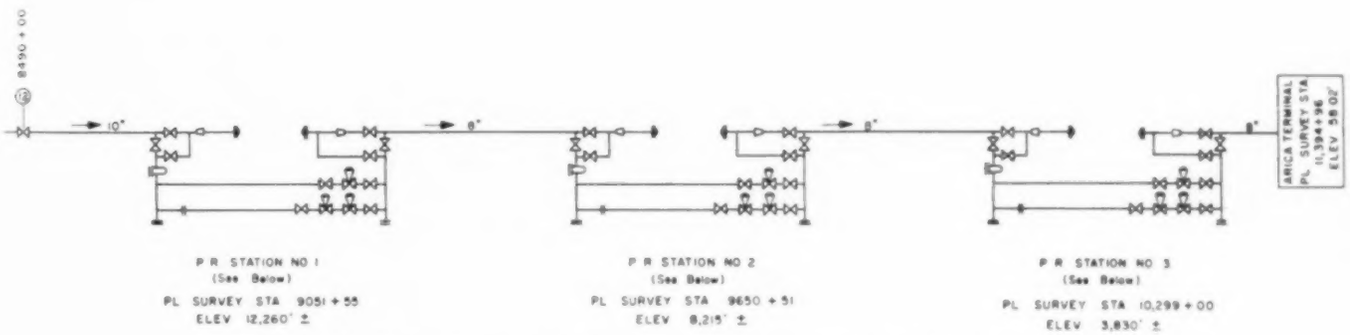
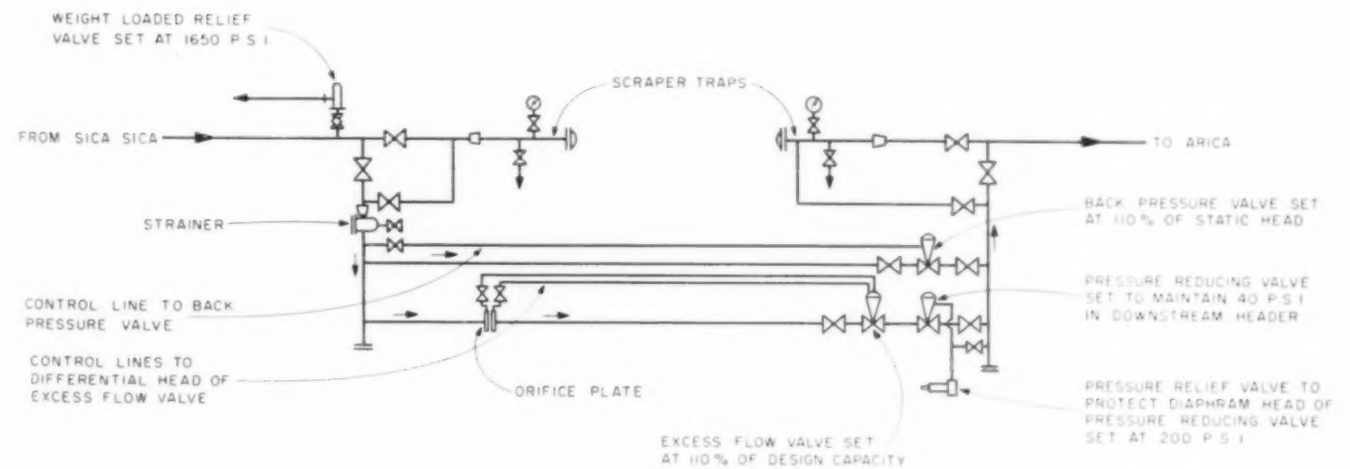


FIGURE 4a—Four pressure reducing stations. Three are on main line; one is at Arica.


WEIGHT LOADED RELIEF VALVE SET AT 1650 P S I
SCRAPER TRAPS
FROM SICA SICA
TO ARICA
STRAINER
BACK PRESSURE VALVE SET AT 110% OF STATIC HEAD
PRESSURE REDUCING VALVE SET TO MAINTAIN 40 P S I IN DOWNSTREAM HEADER
CONTROL LINE TO BACK PRESSURE VALVE
CONTROL LINES TO DIFFERENTIAL HEAD OF EXCESS FLOW VALVE
ORIFICE PLATE
PRESSURE RELIEF VALVE TO PROTECT DIAPHRAM HEAD OF PRESSURE REDUCING VALVE SET AT 200 P S I
EXCESS FLOW VALVE SET AT 110% OF DESIGN CAPACITY

PRESSURE REDUCING STATION, TYPICAL FOR NO.S 1, 2, & 3

FIGURE 4b—Cchematic of pressure reducing station. All motive energy comes from hydraulic power of the line products.

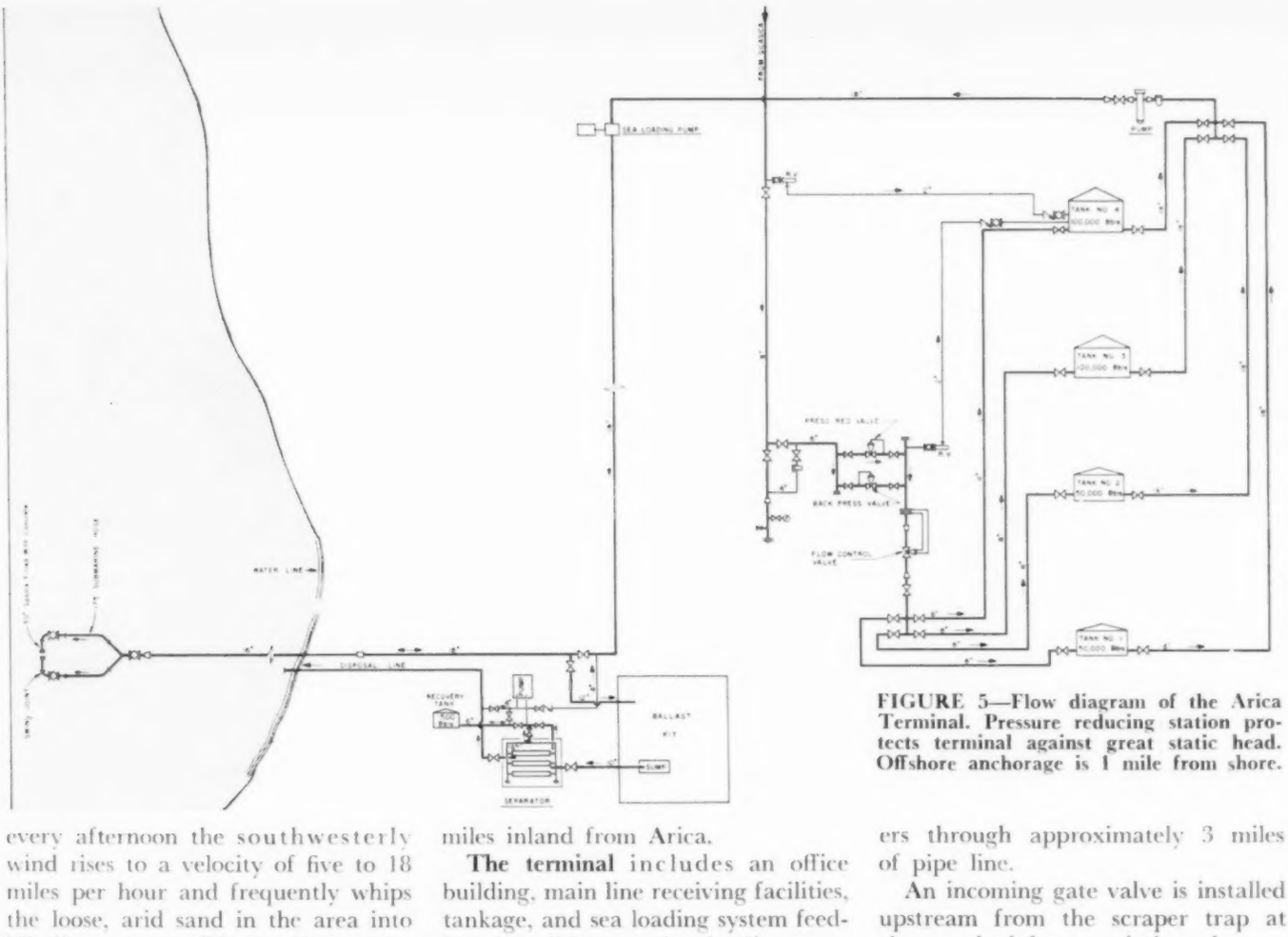


FIGURE 5—Flow diagram of the Arica Terminal. Pressure reducing station protects terminal against great static head. Offshore anchorage is 1 mile from shore.

every afternoon the southwesterly wind rises to a velocity of five to 18 miles per hour and frequently whips the loose, arid sand in the area into blinding storms. These effects were factors to be considered in design. The abrasive sand will collect in machinery, engines and pumps, thereby reducing operating life. The wind also combines with the coastal currents to generate substantial ground swells in the tanker loading zone. The terminal is located approximately two miles inland from Arica.

The terminal includes an office building, main line receiving facilities, tankage, and sea loading system feeding the offshore tanker loading area. Receiving facilities consist of an 8-inch receiving scraper trap, a pressure reducing station, a flow rate controller and a distribution manifold serving four floating roof tanks totaling 300,000 barrels of storage. The crude oil is measured and tested in the tanks and then loaded into tankers through approximately 3 miles of pipe line.

An incoming gate valve is installed upstream from the scraper trap at the terminal fence to isolate the terminal from flow generated by the gravity head in the event of a fire on a high pressure line break in the terminal. A relief valve, set at 1,650 psi, is installed ahead of the gate valve to relieve thermal build up in the main line directly into terminal tankage.

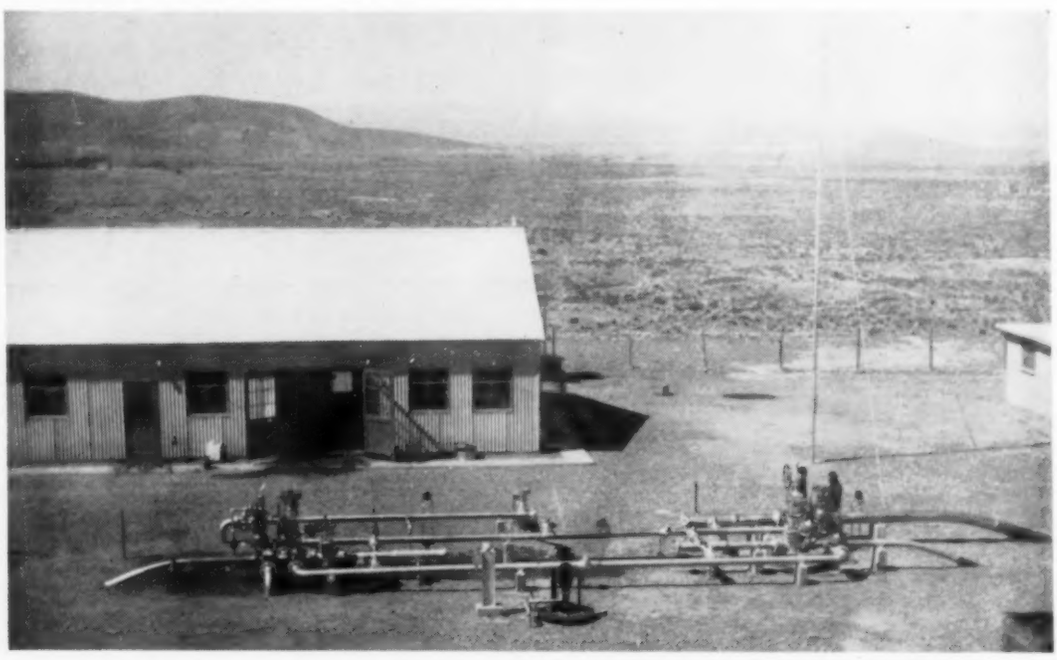


FIGURE 6—Sicasica station and manifold. Double doors open into pump room building; at far right is prefabricated home for station attendant.

The pressure reducing equipment at the terminal operates in a manner identical to the units employed at the upstream installations. The excess flow valve as installed at upstream stations is not used at Arica because the presence of terminal personnel eliminates this requirement. The flow control regulator, with upstream orifice plates, limits the rate of flow into the terminal to 7,000 bpd. The low pressure portion of the pressure reducing manifold is equipped with relief valve set at 150 psi which discharges directly into Tank No. 4. Accumulated thermal expansion, resulting from the action of upstream reducing stations, is ultimately relieved through this valve.

Electric power for the terminal is supplied by two diesel electric sets. One 50-KW unit is for the express purpose of supplying power to the 50-hp electric motor driven booster pump. The 18-inch suction lines from each tank join into a common header that serves as a manifold for the booster pump. The booster pump is a vertical can type pump with 34-inch diameter mixed flow impeller. It will deliver 7,000 gpm at a 27-foot head to the suction of the main tanker loading pump.

Sea Loading System. The main tanker loading pump is a horizontal split-case, single-stage, double-suction unit, directly connected to a diesel engine. The skid-mounted unit will deliver 7,000 gpm at a 229-foot head.

The sea loading line, as schematically shown on Figure 5, runs from the loading pump to the tanker mooring area. This includes 12,000 feet of 18-inch land line and 5,000 feet of 16-inch submarine line. Pipe wall thicknesses are 0.250-inch and 0.375-inch respectively, with pipe material meeting API 5L Grade B specifications. In addition to regular double, enamel coat and felt wrap, the 16-inch pipe was mill coated with concrete to provide the required negative buoyancy. The 16-inch line terminates in a wye connection and two 12-inch diameter, 175-foot long loading hose assemblies.

A 12-inch plug valve has been installed ahead of the wye where the 16-inch line joins the hoses to permit replacement of hose sections if necessary without draining the entire line. The tanker end of each hose terminates in an assembly including a hoisting bridle, 12-inch plug valve, 12-inch elbow swivel joint and a pipe spool filled with concrete. The concrete filled spool will act as an anchor weight for the hose end while resting on the ocean bottom and also protects the flange on the elbow from being damaged during handling operations.

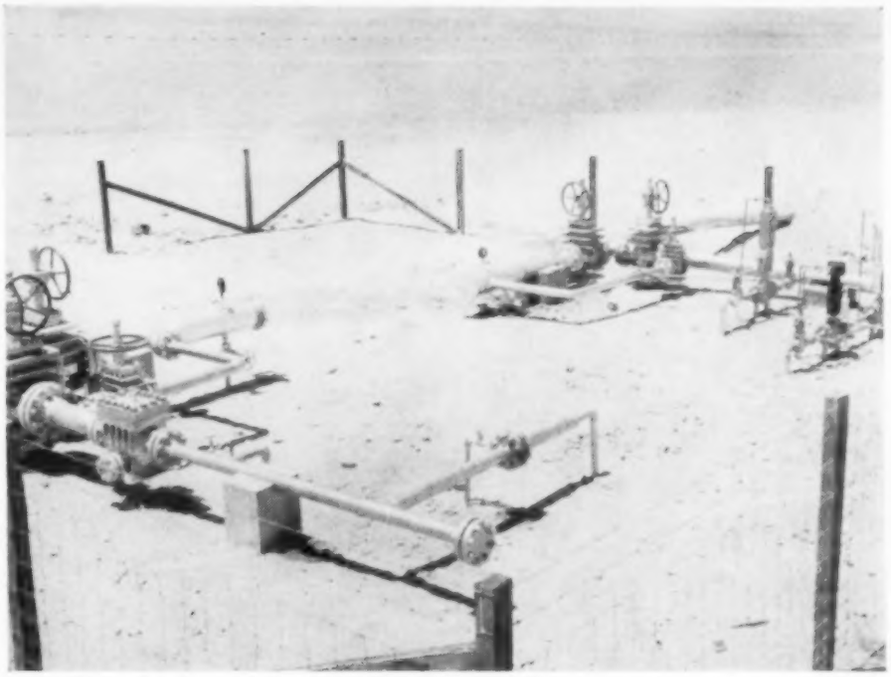


FIGURE 7—Pressure reducing station No. 3 showing complete station. Valves from far right to left are: 1. Pressure reducing valve; 2. Excess flow valve; 3. Back pressure valve.

Sea Berth. The sea berth is located approximately 4,300 feet westerly from the mouth of the San Jose River in 52 feet of water. It is aligned so that tankers will lay bow toward prevailing winds. The berths is equipped with a two-buoy stern mooring system, with buoys spaced 600-feet apart. The mooring buoys are large cylindrical tanks with a heavy metal stay passing through the buoy diametrically at its longitudinal center. A self releasing mooring hook is fastened to the upper end of the stay. Each mooring buoy is held in place by three anchors and 360 feet of chain.

Ballast Water Handling Facilities. Ballast water handling facilities are located on a separate tract of land approximately 5,600 feet from the water's edge. The 18-inch land line passes through the tract. Pipe for ballast water disposal is 12-inch OD, 0.375-inch wall, API 5L, Grade B, lying parallel to the 18-inch line and extending 5,600 feet from the ballast tank area to the mouth of the Rio San Jose. A manifold on the 18-inch line, in the ballast area, permits receiving into, or by-passing of the ballast pit. Ballast water is received through the sea line into the ballast pit which is a fire dike with a capacity of approximately 43,500 barrels. The bottom and sides of the pit are coated with a 2-inch thick reinforced concrete liner. Ballast water, contaminated with oil, is then processed through a four pass gravity type oil separator. The clear ballast water leaving the separator, then flows to the sea through the 12-inch disposal line.

Tanker Loading Operations. When a tanker arrives in the sea berth, it is securely tied to the mooring buoys provided. The loading hoses are picked up and connected to the ship's manifold. Normally, the hose and sea line will be full of water pumped in by the previous tanker.

When connections have been completed between the hoses and the tanker's manifold, the tanker's deballast pumps are started. The ballast water passes through the hoses and the sea line to the ballast facilities, which are located approximately 10,000 feet from the tanker. When the tanker has completed discharge of the ballast and the pumps have been secured, the valves located in the manifold at the ballast facilities are manipulated to connect the sea loading

Continued on Page 60

FIGURE 1—Failure of rolled and welded pipe from cyclic stresses (left). Crack runs parallel to the longitudinal weld and only a short distance from it. There is a large spread in cyclic life. One test specimen failed at 144,000 cycles; another ran for 900,000 without failure.

FIGURE 2—Close-up of fracture along weld seam. Variation in cyclic life probably reflects the variation in the severity of the mechanical or metallurgical notches.

More on High Strength Pipe Tests

Here are some pertinent comments on the article "Technical Advances in High Strength Line Pipe" originally published in the January 1959 issue of PIPE LINE INDUSTRY, pages 26-30. They bear out many of the earlier findings

By H. H. George
Tube Turns, a Division of Chemetron Corporation
Louisville, Ky.

W. A. SAYLOR AND A. B. WILDER are to be commended for their frank presentation of pipe line *failures and fractures* and *the progress being made in research and testing to prevent such occurrences.*

In developing pipe fittings at our plant, fatigue testing procedures are used in evaluating the performance of these fittings. **Throughout such testing it was observed that the pipe used is not always the strongest part of the assembly and that, in many cases, failure was obtained in fatigue without stressing the pipe beyond its yield strength. In some cases the pipe tests were made to obtain a reference for comparison of the fitting strength, and in others the inadvertent failure of the pipe was a by-product of the test.**

Bending fatigue tests were conducted in two ways, one by applying reversed strain cycles of relatively large magnitude at slow cycles, and the other by inducing resonance in the specimen, thereby producing a relatively lower magnitude of strain in the specimen but at high cyclic rates. Both seamless ASTM A106 Grade B pipe without welds and seamless pipe sections of the same

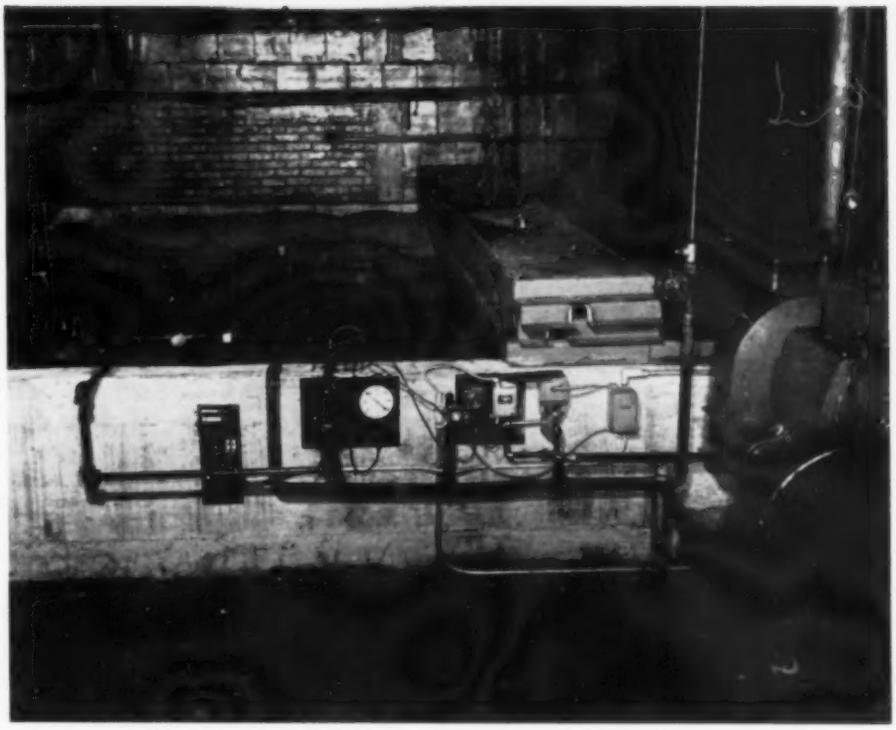
material joined by butt girth welds were tested to failure.

Results of the initial tests by the applied strain method, which were used primarily as a reference in developing stress intensification factors for pipe fittings now included in ASA B31.1 Code for Pressure Piping, are presented in figures 4 and 5 of a paper by Markl.[1] Later unpublished test results, using the resonance method, verified the original evaluation. Similar test results by Blair[2] and Newman[3] also fit research on seamless pipe and butt welded joints.

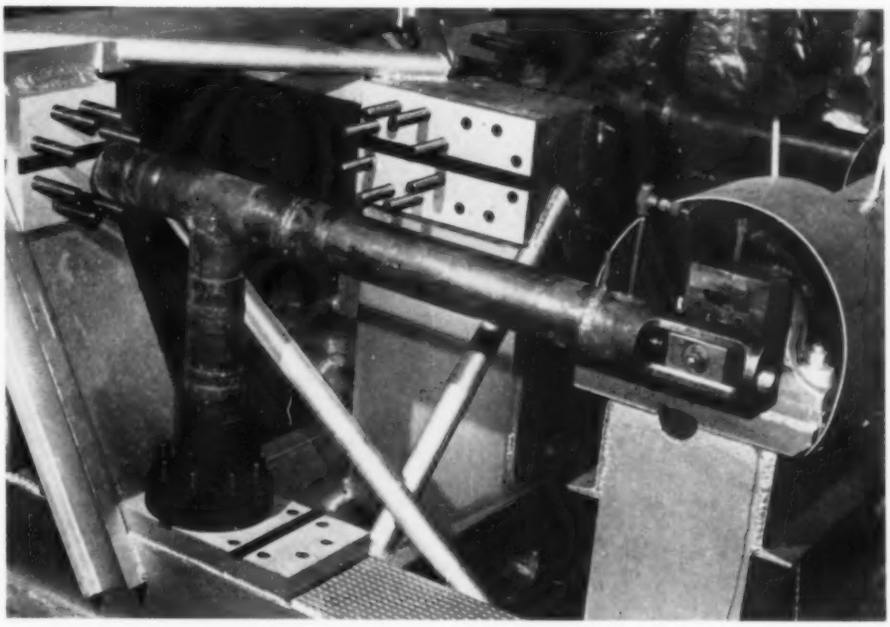
These tests, although not directly comparable to those by the authors—one produced longitudinal failure and the other circumferential failure—demonstrate that pipe, both without and with welds, fails in fatigue if a sufficient number of strain cycles are applied, even though the pipe is not stressed to the yield point. One specimen, after being tested by resonance bending, was cut up for longitudinal tensile specimens, and five specimens fractured during machining before a satisfactory one was made. This material was closely examined, and no cracks were revealed by dye-penetrant examination; yet incipient or micro cracks were present in the entire area of the failure. This appeared to be strikingly similar to the failures reported by the authors occurring during the rail transportation of pipe.

Pressure pulsation fatigue tests, Rodabaugh and George,[4] showed failures more of the type reported by the authors, figures 1 and 2. This phase of testing was used in the development of required reinforcing for branch connections, and it was a revelation to find that the API-5L-X52 welded line pipe would fail under repeated oscillations of internal pressure between about 50 percent and 95 percent of that which would cause the pipe to yield—note the yield strength of the pipe was never exceeded.

Failures were not always in the seam welds but appeared to be associated with the weld fabrication process. After a few tests, the location of the failure in the pipe could be predicted by an examination for defects, notches, scratches, weld undercuts or any geometrical irregularity that might produce a failure in the longitudinal direction. For example, submerged arc welded pipe failed through the pipe wall, but the intersection of the weld overlay and pipe wall was a source of a stress raiser to initiate a crack; flash welded pipe was vulnerable at the protruding edge of the remaining upset portion at the weld section; and resistance welded pipe failed along a slight "V" notch caused by the wheel of the apparatus used to remove the excess material upset in welding.



Cyclic pressure test apparatus. The specimen is water-filled; after air is vented it is connected to the discharge of reciprocating pump. A bypass valve to pump suction is alternately opened and closed to produce pressure cycles as desired.



Cyclic bending tests were run with this test machine. Pipe is anchored at left and forced to deflect at right. The specimens are water-filled to aid detection of failure. Several amplitudes were used for each type of specimen.

All failures did not start on the outside, but, in some cases, the slight irregularity in the root pass of the girth weld caused by the start of a new welding rod produced a longitudinal notch that was the source of a local intensification sufficient to initiate a crack. It might be mentioned that the circumferential stress is of a higher order on the inside of a pipe than on the outside, and, as a result, defects of the same type on the inside may cause shorter fatigue life than those on the outside under the same pressure conditions. These again support the author's caution to avoid surface defects in the product and gouges or lacerations during construction. Up to the present time no failures of this type have occurred in seamless pipe when attached to the test specimens.

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[4] "Design and Strength of Welded Line Branch Connections," by E. C. Rodabaugh and H. H. George, *Journal of the Pipeline Division*, Proceedings of the American Society of Civil Engineers, Vol. 83, No. PL 1, March, 1957, pp. 1193-1 to 1193-34.

ACKNOWLEDGMENT

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About the Author

H. H. George graduated from the University of Pittsburgh with a B.S. degree in physics and engineering in 1935. He earned his M.S. in physics from the same institution in 1939. As manager of the research section of Tube Turns he is responsible for the design of all of the company's piping components. His principal professional interest lies in the field of metal fatigue.

Bolivian Line

Continued from Page 57

line to the 18-inch oil line from the terminal.

Booster and sea loading pumps at the terminal will then start pumping oil to the tanker. The tanker will receive approximately 2,800 barrels of ballast water, which is the line fill between the ballast pit and the tanker. When oil arrives at the tanker, flow is diverted into oil compartments. Pumping will continue until the tanker has received the full tender of crude oil. When the shipment is complete, the tanker loading pumps at the terminal are stopped.

De-ballast pumps on the tanker are then re-started. The direction of flow in the submarine pipe line is reversed and the 2,800 barrels of ballast water received aboard the tanker is pumped back into the oil line. Displaced oil moves through the 16-inch line into the 18-inch line toward the terminal and into the last storage tank from which the tender was made. When ballast water arrives in the manifold, at the ballast water facilities, de-ballasting is stopped and all valves aboard the tanker, those in the ballast manifold and those at the terminal, are closed. The tanker is then disconnected from the sea loading hoses and the hoses lowered to the ocean bottom.

A low flow control protects both terminal and pumping units from damage in the event a tank is pumped dry or a valve is shut off in any part of the flowing system by shutting down the units when the flow falls below 1,000 bph.

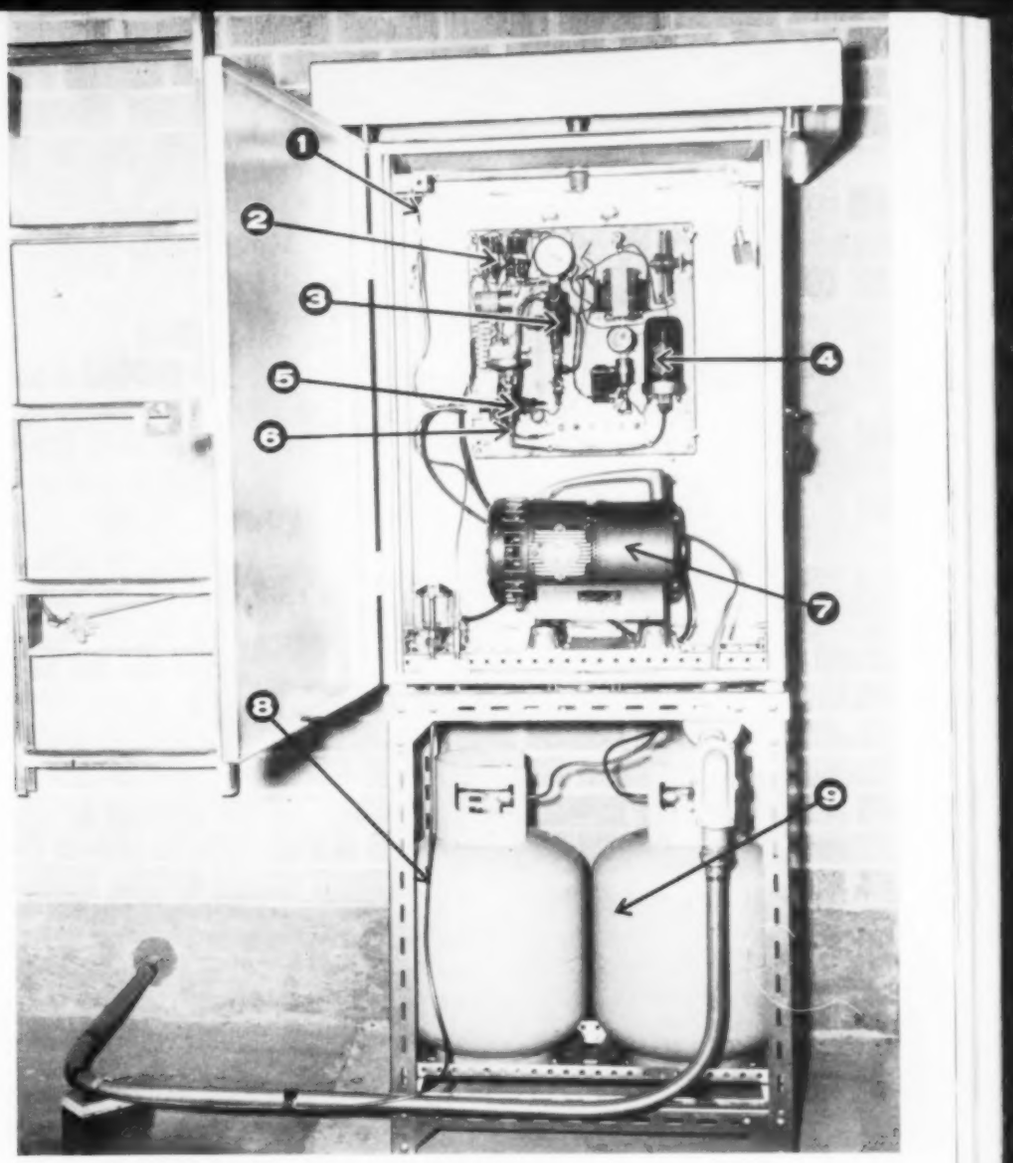
Construction of Submarine Line. The 16-inch diameter, concrete coated sea line was pulled into its final position from a barge anchored in the sea berth area. The tanker mooring buoys were placed in their permanent positions before pulling the sea line. A third temporary buoy, with a ten-ton anchor and 90 feet of 3-inch chain was placed 600 feet beyond the end of the final position of the pipe. To this buoy and the outer permanent mooring buoy, a 60-ton barge, containing a tractor with tail winch was moored in such a position as to provide a direct pull on the pipe line from shore. A wire rope was then strung from the beach to the tail winch on the pulling barge.

On shore, the 16-inch pipe was welded into 15 sections uniform in length. These sections each had 55-gallon steel drums banded to them to limit negative buoyancy to 8 pounds per foot of pipe. Four sideboom tractors lifted the first section, and it was pulled into the water by the winch located on the barge tied 4,600 feet offshore. The cable capacity of the spool on the tail winch was greater than the length of each pipe section, but insufficient for two sections. When the first pipe section was in the ocean, the pulling cable on the barge was snubbed off with a tail piece. Then the slack portion was cut close to the spool on the winch with a cable cutter, and the cable on the spool was then reeled off into the barge. The snubbed off end of the pulling cable was then re-spooled to the winch.

Simultaneously with the cable re-spool operation on the barge, the tie-in weld joining the pipe section in the ocean to the next section on land was in process. This sequence of operation was repeated until the entire sea line was in place. This method of pulling the pipe in along the ocean bottom was used to minimize the effects of the heavy ocean swells which prevailed at the port of Arica during construction. After the pipe was in its final position on the ocean bottom, the outer end was raised off the bottom with a truck mounted winch aboard a 100-ton steel barge. The pulling head was removed and the wye assembly with loading hoses was attached. The entire assembly was then lowered to its final resting place in the ocean bottom. —**The End**

About the Author

Edison E. Mincheff, senior engineer with Williams Brothers Company of Tulsa received a B.S. degree in mechanical engineering from the University of Kansas in 1949. He spent two and a half years as a design engineer for Bendix Aviation Corp. and six years as assistant to the Chief Engineer of the Great Lakes Pipe Line Co. before joining Williams Brothers Company in 1937. He is a registered professional engineer.



Major components of the new combustible atmosphere indicator designed by Great Lakes Pipe Line Co.: 1—exhaust line; 2—alarm circuit; 3—test valve; 4—ignition coil; 5—combustion chamber; 6—spark plug; 7—air sample pump; 8—air sample line (the larger conduit contains the electrical wiring); 9—propane. Each propane bottle lasts about a month. The full bottle automatically cuts in when the other empties.

Great Lakes Pipe Line Company researchers develop a detector based on a new propane-air mix principle

New Detector Guards Unattended Station From Combustible Hazards

A NEW INSTRUMENT for detecting combustibles in the atmosphere of pump stations has been developed by Great Lakes Pipe Line Company's Kansas City Research Laboratory. The novel instrument is now being used to guard a remote-controlled pump station on the company's system.

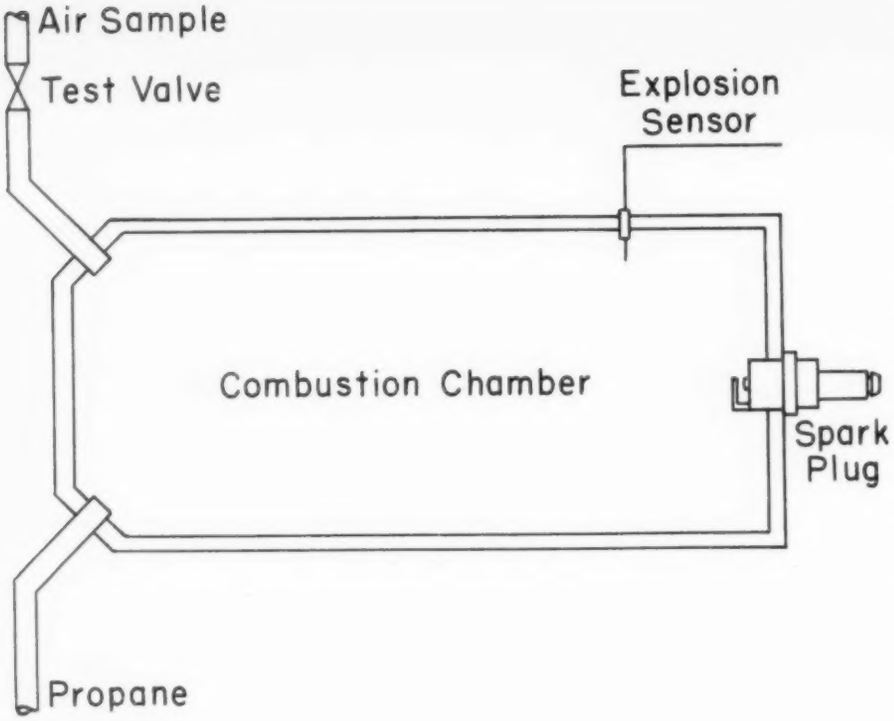
The device was first installed on an experimental basis at the Topeka, Kans., station. It signals the control point at the El Dorado, Kans., station, about 100-miles away—if, and when, the atmosphere inside the pump room of the unattended station becomes dangerous because of an accumulation of gasoline vapors.

How It Works. **Great Lakes researchers studied a number of possibilities of solving the problem and finally decided on a technique which is based on maintaining a near explosive atmosphere in a spark chamber. This causes a controlled explosion and sets off an alarm at the control point whenever enough gasoline vapors enter the pump room.**

Here's how the Great Lakes indicator works: An air sample, taken from a trench near the pump, is drawn outside the building into a combustion chamber containing a spark plug. Twenty-four-times each minute the plug sparks. If the atmosphere inside the chamber is combustible there is a small explosion which activates a signal circuit to El Dorado.

The air in the chamber comes from the pump room and the gas from propane tanks under the device. Both incoming lines are equipped with flame arresters, so there can be no explosive feed-back.

The small amount of propane enriches the combustion chamber atmosphere to the point that an explo-



Air sample is drawn from pump room into combustion chamber pre-enriched with propane gas. If air sample contains sufficient gasoline vapors to make air-gas mixture in chamber combustible, spark plug sets off explosion which activates hazardous gas alarm circuit. Every 15 minutes air supply is cut down so air-propane mixture in chamber becomes combustible and device can check itself. If no explosion occurs during test period, equipment failure alarm is activated.

sion will occur in the chamber if the air sample from the pump room contains as much as 30 percent of the gasoline vapors necessary in an air-gas mixture to make combustion a possibility.

Safety Factor. Thus, the safety factor is considerable: Before the pump room atmosphere becomes combustible, there would have to be more than three times the amount of gasoline vapor than is present when the indicator gives the alarm. The 30 percent figure, incidentally, is adjustable. The device can be set to detect the percent of combustible gasoline vapor desired.

The device also signals fuel oil leaks in the pump room even though such vapors never get rich enough to ignite. To take care of this contingency the mouth of the copper tube through which the air sample is drawn is located only a few inches from the bottom of the trench. A leak of any consequence would soon fill the trench and cover the bottom of the tube so air could no longer be sampled. This absence of air has the effect of enriching the propane-air mixture in the combustion chamber until an explosion occurs, and El Dorado is notified that something is wrong at Topeka.

What about equipment failure? What if the device should break down and fail to give an alarm when it should? First of all, the spark plug is dependable and will last indefinitely. The explosion chamber is brass and the rest of its metal parts also are corrosion resistant, so failures from these sources would be almost non-existent.

Self-Checking. But aside from those factors, a feature has been built into the device to allow it to check itself. Every 15 minutes, the air supply from the pump room is reduced so a propane explosion will take place in the combustion chamber. This isn't signaled to El Dorado as an alarm, because operators there wouldn't know whether the device was signaling "danger" or a false alarm. So the self-checking signal is sent to El Dorado on a separate circuit. If there isn't an explosion during the test period, a signal is flashed, and operators know that the indicator needs tending and possible repair.

During most of the experimental period, the Topeka equipment was set up to signal El Dorado only in the event of trouble. It was up to the El Dorado operators to actually shut down the unattended station. However, the device could be made also to shut-down and lock-out the station when it flashed the alarm signal. In that circumstance it would not be possible to activate the next start-up from El Dorado. This reduces the possibility that the station might accidentally be restarted before the trouble was corrected.

For a research project the going was exceptionally smooth, although there was one problem which stymied the department for a time. Periodically the spark would fail. Some of the time the failure would occur during the test cycle, and El Dorado would receive an equipment failure signal.

At first water vapor condensation was suspected. Because the air tube comes out of a relatively warm building to the outside weather, the winter air could have caused water to condense and be pulled into the combustion chamber. Wrapping the outside portion of the tube with a soil heating cable raised its temperature to about 100 degrees, and the temperature inside the combustion chamber already was sufficiently warm.

But heating the tube, while a good idea and one which will undoubtedly ward off future trouble, did not solve this particular problem. The trouble later was discovered — not in any inadequacies of design or construction, but in a defective electric switch.

During summer the device probably will need cooling. This can be accomplished by letting more air into the cabinet, either manually, or by use of a thermostat.

Although none of Great Lakes' other automatic stations (Lee, Prophetstown, Donahue and Roland) have combustible atmosphere detectors at the present time, they are not unprotected from a safety standpoint.

The pumps' packing gland drain boxes are connected to a sump tank. If the mechanical seals on the pump fail, then the leaking product is conducted to the tank. Should 10 gallons of product accumulate there, a float mechanism automatically shuts down the station. The pump-room trenches at Topeka also are connected to this sump tank, thus giving double protection in the event of a leak or break.

Plans are under way to equip other Great Lakes' unattended stations with the new safety device. **—The End**

By
Pipe Line
Pete

IDEAS FOR THE FUTURE!

... in pipe line engineering, construction and operations

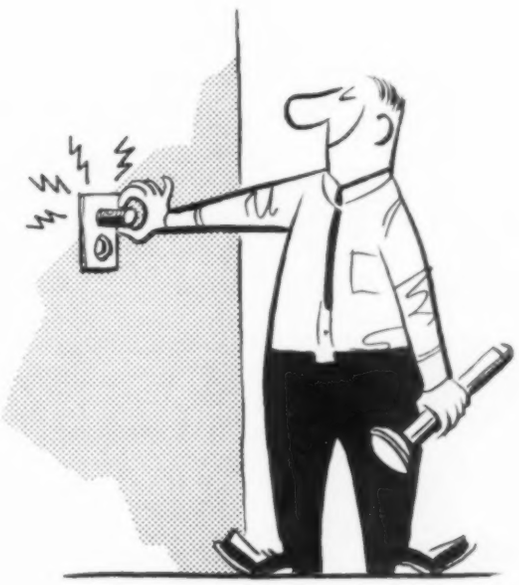
What's Ahead in Batteries!

We'll be recharging dry cells. The world's supply of natural manganese dioxide ore for dry cell batteries used in flashlights, radios, hearing-aids, etc., is nearing exhaustion. For this reason, the National Bureau of Standards investigated the possibility of recharging the dry cells with an eye toward using the batteries over again.

Results—The batteries can be recharged by an AC-DC method several times, greatly increasing their ultimate usefulness.

Solid electrolyte battery has potential. A battery with a shelf-life of 20 to 30 years has many desirable characteristics. Its solid electrolyte is silver chloride. It has a silver anode and a cathode of chlorine and iodine monochloride liberated from potassium tetrachloroiodide. It features an unusual cup-like shape.

New solar battery. A cadmium sulfide photovoltaic battery which converts solar energy into electrical power has been greatly improved by the Air Force. Demonstration units gave 50 milliwatts of power at 8 volts in direct sunlight.



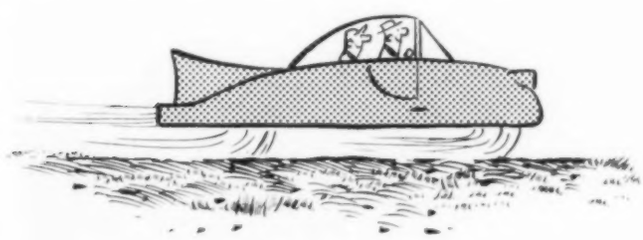
Improved Map Paper for Pipe Line Maps

Bonding two sheets of 2-mil thick map paper to a polyethylene terephthalate film has greatly increased the strength and dimensional stability of map paper. This idea, which was developed by Army Engineer Research and Development Laboratories, may mean better pipe line maps.

There'll Be a Flying Carpet in Your Future!

Time was when anyone who described a means of shimming through the air just above the surface of the ground would have been considered a witch or a warlock. But thanks to a phenomena of air that provides a lot of lift for the horsepower, we'll soon have our flying broomsticks—or more properly our flying carpets!

Models of the new type vehicles were demonstrated in the caucus room of the U.S. House of Representatives recently. They were taken quite seriously, too.



Here's the way they work. Blowers or jets create the air cushion upon which the vehicle rides. This cushion elevates the craft a foot or so above the ground, and as it is propelled through the air, it eliminates the normal friction between a surface craft and the ground.

Aside from providing us with a good way to come to work and go fishing, how will the craft benefit pipeliners?

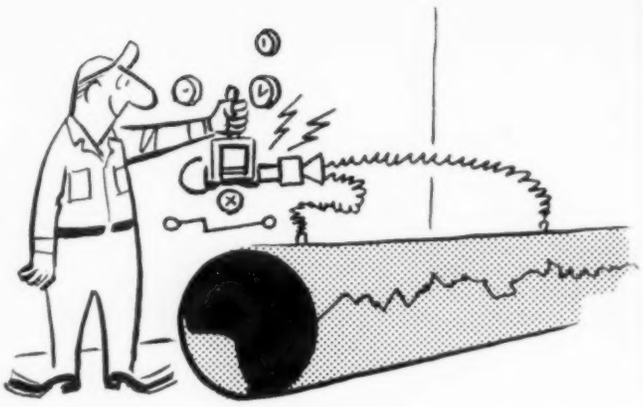
One way, it will enable crews to reach line breaks, etc., in nothing flat. The first such vehicle—scheduled to be marketed for about $4,000 in 18 months by Spacetronics, Inc., and Aluminum Company of America—will be 26 feet long, 20 feet wide, and it will carry six passengers with their baggage.

But a larger vehicle which will cost about $40,000 is being designed. Other companies doing experimental work along these lines—Piasecki Aircraft Corp., Chrysler Motor Corp., and Aerophysics Co.

New Discoveries in Corrosion

Experiments sponsored by the Corrosion Research Council on the stress corrosion cracking of stainless steels indicated that the application of anodic currents as small as 0.03 milliamperes per square centimeter can accelerate cracking while cracking can be prevented by impressing a cathodic current density of 0.04 milliamperes per square centimeter.

Some metals give up gas as fatigue cracks progress, according to the National Bureau of Standards. A transparent tape was applied to the surface of an aluminum alloy specimen in which a minute fatigue crack had been induced by several thousand cycles of stress. When the specimen was then stressed for additional 1,000 cycles, small bubbles formed under the tape. Additional work showed that sizable bubbles appeared before the fatigue crack became large enough to be seen with the naked eye. Unfortunately, this phenomenon may be due to surface reactions; the bubbles cannot be produced by all metals.



Electrical Gadgets and Circuits are Small, Small

When the author of Dick Tracy invented the wrist radio, little did he know what he was starting. Nearly every company in electronics is working on subminiature components. Texas Instruments Inc., has a complete circuit of 12 components no bigger than the head of a match. The company says that 1 cubic foot of these devices would replace all the computer circuitry in the U.S. today!

Permanent magnets smaller than a hair—even a blonde's. Cunife wire magnets made of 60 percent copper, 20 percent nickel and 20 percent iron can be cold drawn into magnets as small as 0.005 inch in diameter.

Better Spectacle Lenses are Coming

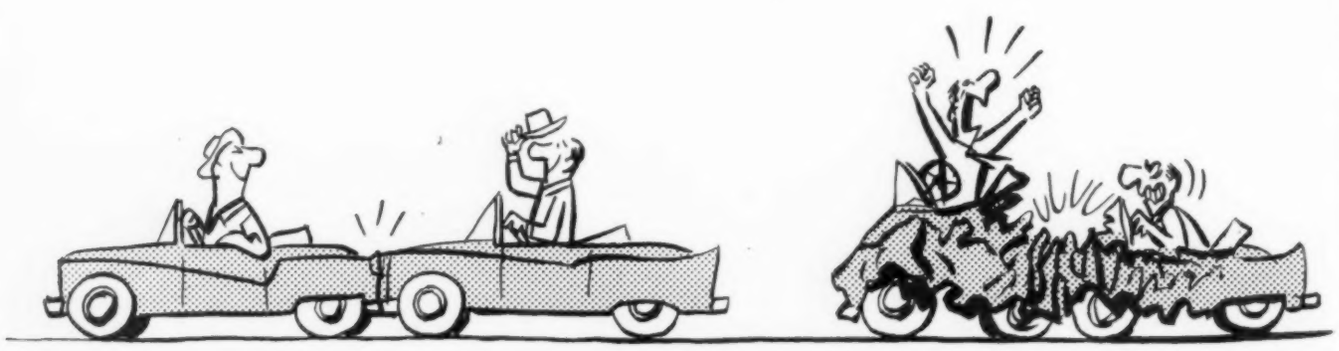
About one lens out of every five is inferior near the edge: that is, if it was ground by one of the five leading lens makers in the U.S. Bureau of Standards measured 300 such lenses and found the batting average high but far from perfect. So if your glasses are giving you a headache, better check on the periphery of the lenses.

Traffic Tale of Two Cities

This is a true tale of two cities about 45-miles apart, which were studied at great length by Applied Psychology Corp., under contract with the Bureau of Public Roads, U.S. Department of Commerce:

City "A" has a population of about 50,000 and City "B" has a population of about 40,000. City "A" has more wealth, a higher median income, better educated populace, more crime and in general is more aggressive than its cousin. Psychologists found City "B" to be less aggressive and more friendly. It is slowing down in development whereas City "A" is accelerating.

So far as traffic is concerned, City "B" has "A" beat despite poor driving topography. There are fewer wrecks, fewer fatalities—and more friendliness!



Rules of Thumb

and Engineering Data Sheets for the Pipeliner's field notebook

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These practical aids give quick, reasonably accurate answers to design, maintenance and cost estimating problems. PIPE LINE INDUSTRY will pay $25 for each chart, nomograph or data sheet published—$15 for each Rule of Thumb. Send your ideas to PIPE LINE INDUSTRY, P. O. Box 2608, Houston, Texas

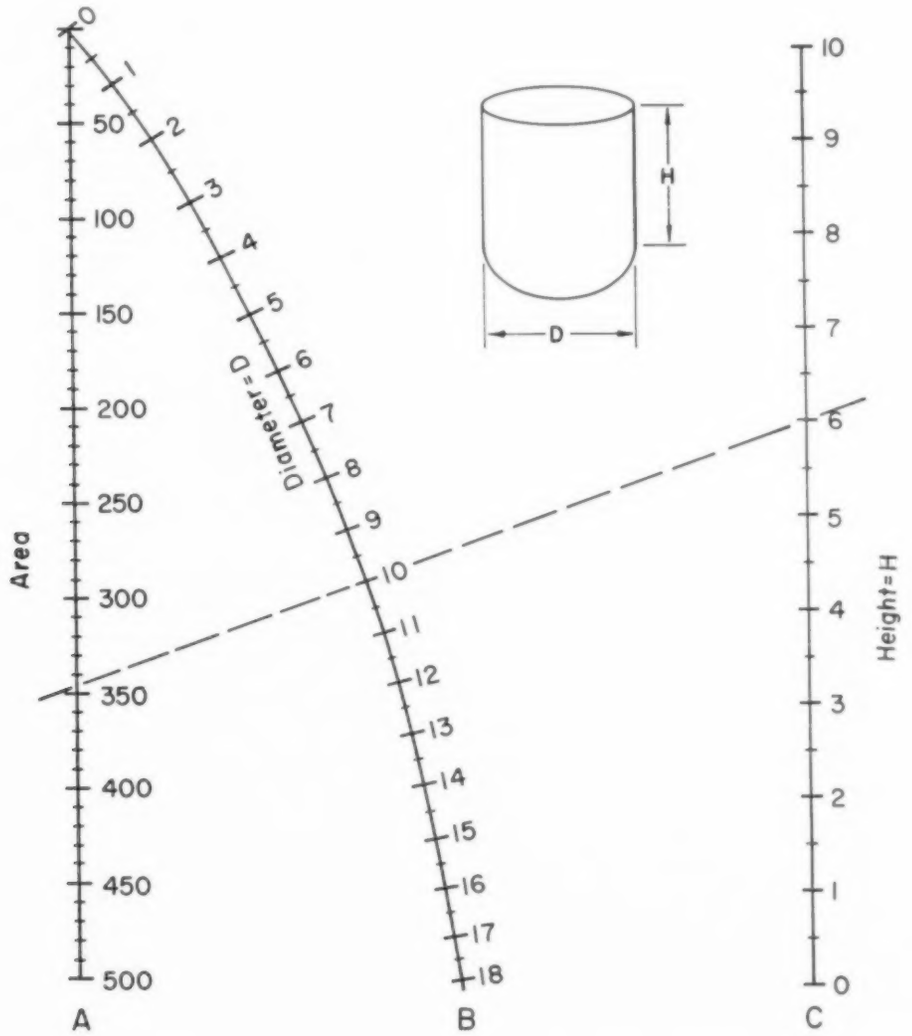
Engineering Design

—64—How to estimate tank areas quickly

Use the accompanying nomograph for estimating the area of cylindrical tanks quickly. Included in the total will be the inside or outside area of top, bottom and side. This will be handy in estimating painting requirements, etc.

Example: Find the square feet of metal required to fabricate a cylindrical tank, 10 feet in diameter and 6 feet high. Simply connect 6 in Column C with 10 in Column B and read the answer, 347 square feet, in Column A.

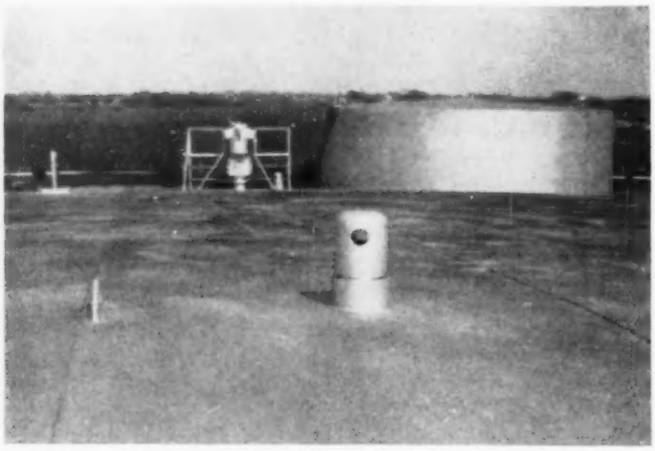
For large diameter tanks divide height and diameter by 10 before reading the nomograph, then multiply the area from Column A by 100 to get actual square footage of inside or outside tank area. For small vessels substitute inches for feet.



How to do it

PIPE LINE HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas



Torque Tube Eliminates Footwork on Storage Tank

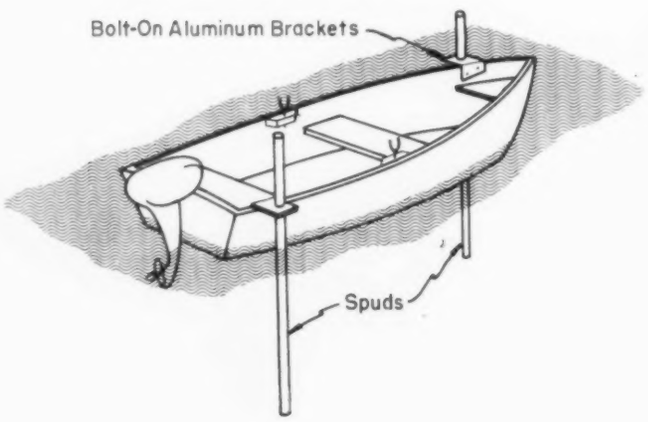
Lug an 18-inch stilson wrench up the ladder on a 50,000 barrel tank a few times, and you'll find yourself getting labor-saving ideas. This particular idea not only saved the trip with the wrench, it earned the idea man $10 as well. He simply welded a small diameter pipe nipple through the end of a bull plug, called it a "torque tube" to impress the brass and keep them from suspecting that the whole idea grew out of pure doggone laziness. Now he can remove the bull plug by the simple method of slipping a cheater through the "torque tube" giving it a twist.

If you're the lazy type workman who thinks up labor-saving devices, just whip out that stub of a pencil in your pocket, draw a sketch and give us the details. Ten bucks is $10, you know.

Ohms Law Chart Simplifies Values for DC Calculations

An "Electrical Rose" shows quickly the relationship between values for DC calculations.

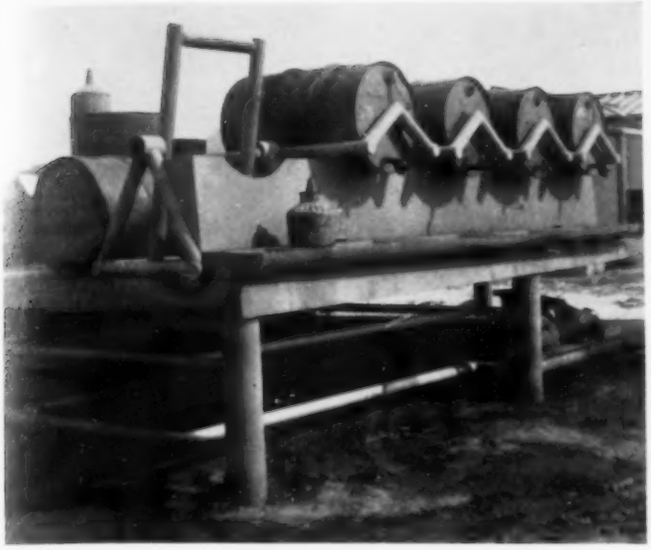
Four segments illustrate Ohms law equations for watts, volts, amperes and ohms. This simple chart presents electrical values at your finger tips.



Spuds for Boats Make Line Soundings, Repairs Easier

Bolt two sleeves—one at the right rear, the other at the left front—on an aluminum boat and turn it into a "spud barge" for line location work. Despite current, the skiff can be held stationary by plunging the poles into the stream bottom.

This solves a vexing problem for engineers who are saddled with the task of making soundings, etc., of an underwater line. Ordinary anchors allow the boat to weave in the current. What's needed is a stationary platform from which to measure the depth of the line and provide a target for short-based transits. These poles and sleeves solve the problem in relatively shallow streams.



Better Barrel Tilters Continue to Spring Up

Nothing's handier than 55 gallon drums. In World War II GIs on Pacific islands made wind-driven washing machines, rafts and barbecue grills from them. Since then, pipeliners have floated lines across thousands of miles of swamp, rivers, etc., by the simple expedient of strapping the pipe to a proper number of drums.

But one of the handiest uses yet devised for the drums is that of dreaming up ways of tilting them over and selling the ideas to PIPE LINE INDUSTRY for 10 bucks! apiece! From the editor's viewpoint, the real trouble is that each new drum tilter seems better than the last, and as a result, he is forced to run them in PLI.

So . . . here's the latest in drum tilters. It's made of scrap pipe ranging from 2 to 4 inches and it has a pan to take care of spillage. You figure out the rest of the details!

Simple Step Assembly Makes Truck Engines Accessible

Take a look at the photo, and you'll wonder why you didn't think of this one yourself. This simple step assembly that fits over a front tire can speed engine repairs on large, modern-day trucks.

Making the step is just as simple as it looks. Bend reinforcing bar as shown, fitting it over the tire of a front wheel. Weld in a cross brace, and then add the diamond plate step.

Where truck tires are of different size, different size steps can be used.

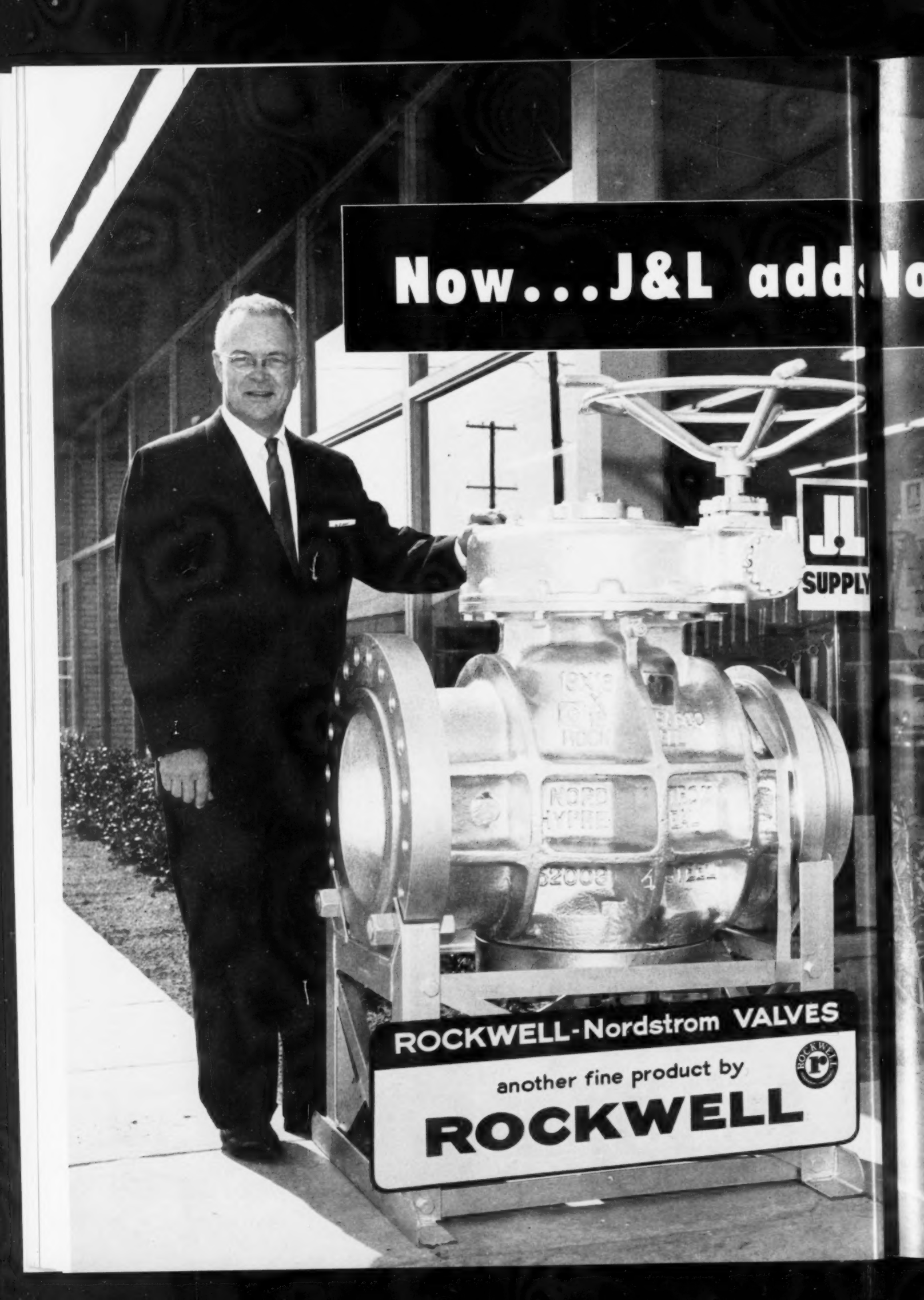
Metal Boxes, Pipe Stand Provide Equipment Storage

For supporting two spare joints of emergency pipe and to provide for readily accessible repair equipment, such as emergency sleeves, bolts, gaskets, etc., one company has set up a pair of metal boxes on pipe stands about 20-feet apart, with saddle-brackets welded on opposite sides of the vertical pipe support, as shown.

Such emergency equipment caches are usually placed at locations along the course of the pipe line that are easily reached by truck.

Each metal box is hinged on one lower edge to the floor, and a hinged hasp and a mating loop to the lower edge on the opposite side—permitting the boxes to be locked by padlock.

The saddle brackets welded to the upright supporting columns support the emergency pipe and keep it off the ground.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76

Shop-Made Indirect Heater Stops Regulator Freeze-Ups

A shop-made heater created from a joint of 12 inch pipe keeps the regulator warm on the pictured installation in the coldest weather.

It consists of a joint of 12 inch pipe full of water with a flue and coil of 2-inch pipe to carry the gas. It runs to a point inside the brick meter house so that the interior is kept slightly warmer than the outside. The coil of pipe is on the upstream side of the regulator and the 4-inch flue runs from the outside of the building to a point above the roof.

As shown, the flue is equipped with a jet-type burner supplied with gas from the downstream side of the regulator. A thermostat is placed in the water bath just above the burner so that a minimum of fuel is used. It is only necessary to keep the water in the pipe around 60° F. to prevent the regulator from freezing.

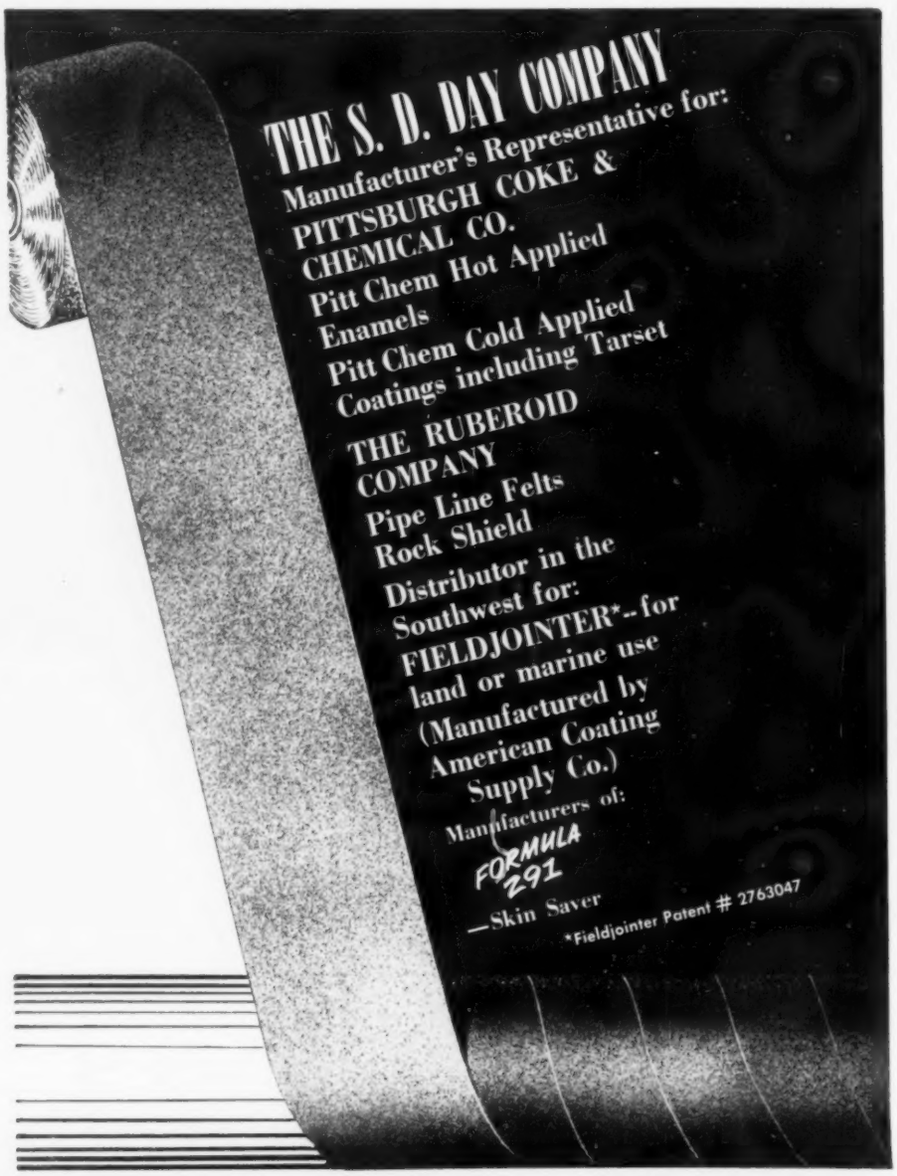
In order to keep the fire from blowing out, and to protect the burner from the elements, a hinged cover was made by cutting the end of the joint of 12-inch pipe on an angle and welding a cap over the end. It is hinged

with a piano-type hinge made of 3/8-inch pipe running along the bottom. This lid is thrown down after the flame is inspected and the heater placed in operation.

Reach Buried Valves With Long Handled Wrench

There are numerous valves which are buried below ground level on crude gathering systems. Since some of these valves must be operated frequently, it is sometimes awkward to manipulate them with a conventional valve or pipe wrench.

This long reach valve wrench was constructed to reach buried plug valves with a minimum of time and effort. The handle and stem of the wrench are made from discarded sucker rods. The lower portion is cut from discarded steel plate. A minimum of welding time is required to construct the wrench which is an excellent time-saving tool.



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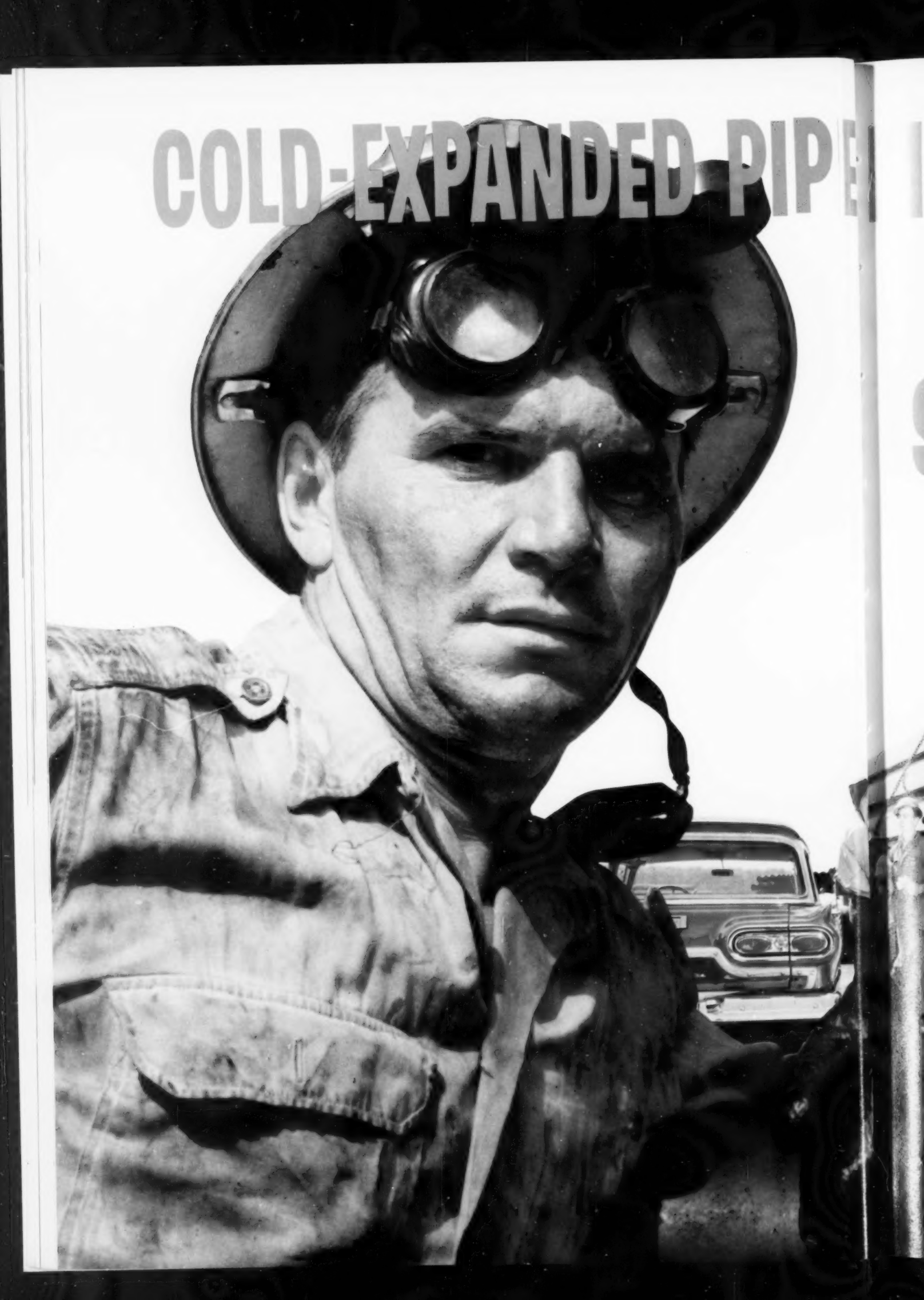
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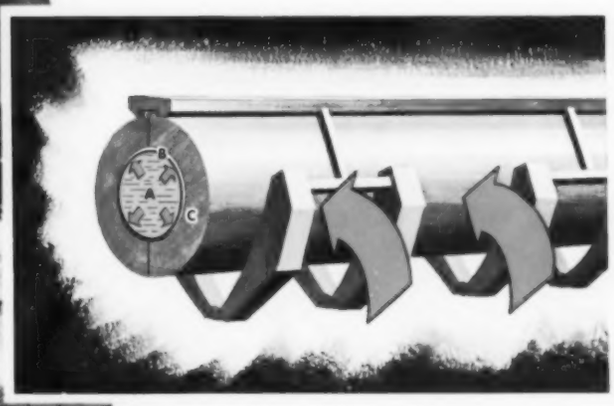
For particulars about Youngstown Electric Weld Line Pipe, contact our sales and field engineering offices strategically located throughout the oil and gas-producing country. The Youngstown Sheet & Tube Company, Youngstown 1, Ohio.



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WHAT'S HAPPENING IN PIPE LINE CONSTRUCTION

By **Donald G. DePugh,** Construction Editor

Construction Underway on Midwestern's Portland, Tenn.-Joliet, Ill. Gas Line

Contractors have started work on Midwestern Gas Transmission Company's 350-mile, 30-inch line from Portland, Tenn., to near Joliet, Ill.

Contracts on the main line were awarded to Grayco Constructors, Inc., Sharman, Allen, Gay & Taylor, Inc., Panama, Inc., Majestic Contractors, Ltd., and Bechtel Corporation. Houston Contracting Company is building the 6000-horsepower compressor station, the first of two planned by Midwestern, at Portland.

Grayco's section includes 51 miles from Portland to near Cromwell, Ky.; Sharman, Allen, Gay & Taylor will lay 43 miles in Kentucky from Cromwell to the Ohio River; the 53-mile spread between the Ohio River and White River near Algiers, Ind., will be constructed by Panama, Inc.; Majestic Contractors has the 53-mile segment from Algiers to the Wabash River near Terre Haute, Ind.; and Bechtel will build the 148-mile section from Wabash to the terminus near Joliet.

The $50 million project crosses six rivers including the Ohio, Wabash and Green in Kentucky, the White River in Indiana and Kankakee and Des Plaines in Illinois. Contractors on river crossings include Sharman, Allen, Gay & Taylor; Collins Construction Company; Pentzien, Inc.; Popich Marine Construction, Inc.; and Missouri Valley Dredging Company.

Construction plans on Midwestern's line include double-jointing approximately 200 miles of the 30-inch pipe and internal coating for the entire system. This will be the first complete system to be internally coated. Bechtel has the contract for double-jointing the pipe and also made preliminary engineering studies and right of way acquisition for Midwestern.

Construction began last week and should be completed in early fall in time to deliver 255 MMcf of gas daily to the Chicago area for winter season. Tennessee Gas Pipeline Company will construct additional station facilities on its system to deliver gas to Midwestern at Portland. Tennessee also plans to construct about 160 miles of 36-inch loops to boost its delivery to Midwestern. Midwestern will supply about 360 MMcf of gas daily by its third year of operation.

Texas Eastern Plans 22-Mile, 14-Inch Line

Texas Eastern Transmission Corporation will start work soon on a 22-mile, 14-inch gas line from Rayne field in Acadia Parish, La., to its Opelousas, La., compressor station.

Texas Eastern received FPC authorization to purchase leasehold producing interests of the Rayne gas field from Continental Oil Company, Sun Oil Company, General Crude Oil Company, and M. H. Marr, joint developers of the field.

The $134 million purchase will make available for Texas Eastern about one trillion cubic feet to its natural gas reserves. The FPC ruling included authorization to construct additional 30-inch loops on its main line between Kosciusko, Miss., and Uniontown, Pa., at a cost of $49 million. Texas Eastern also received final approval on its application to increase daily sales of its system by 100 MMcf.

Trans-Prairie Plans Crude Line in British Columbia

Trans-Prairie Pipelines Ltd., becomes the third company seeking permission to construct a crude line from the Milligan Creek, British Columbia area. The proposed line would extend from Milligan Creek, Beatton River and Boundary Lake fields to Dawson Creek and Fort St. John refineries. Peace River Oil Pipe Line Ltd., and Gibson Associated Oil Ltd., also plan a crude line from these fields.

Trans-Prairie is proposing to extend its gathering system in Saskatchewan in order to serve South Halbrite pool in Midale field.

Southern Natural Awards Contracts on 350 Miles

Contracts have been awarded by Southern Natural Gas Company on 350 miles of its 500-mile expansion program which was given FPC examiner approval last month.

The main line loops will be laid in Mississippi, Alabama and Georgia. Five contractors will start work on the 14-24-inch looping this month. Contractors include Oklahoma Contracting Company, C. S. LeNoir Construction Co., Buchanan Contracting Co., Harbert Construction Corp., and Sharman, Allen, Gay & Taylor.

Oklahoma Contracting will build 104 miles, 18- and 24-inch in Alabama and Mississippi; LeNoir will lay 61 miles, 20-and 24-inch in Mississippi and Alabama; Buchanan Contracting will construct 80 miles of 16-inch in Georgia; Sharman, Allen, Gay & Taylor has 65 miles of 6-, 12-, 16- and 20-inch in Louisiana; and Harbert Construction Corp. has contract on 46 miles 14-20-inch in Georgia.

Trunkline Lets Contract On Major Expansion Program

Trunkline Gas Company has awarded contracts to 10 contractors for construction of approximately 900 miles of laterals, loops and main lines.

Contractors, who will begin work this month, include Western Pipe Line, Inc., Engineers Limited Pipeline Co., C. S. LeNoir Construction Company, Sam Carline, Inc., Panama, Inc., H. H. Null, Sharman, Allen, Gay & Taylor, Inc., Grayco Constructors, Inc., Contracting & Material Co., and Panama-Williams Corporation.

Trunkline's construction includes a 204-mile 26-inch main line from Tuscola, Ill., to the Indiana-Michigan border; 464 miles of 30-inch loops between Longville, La. station and Tuscola plus 45 miles in Texas, and 183 miles of gathering lines in Texas and Louisiana.

Columbia Gulf Transmission To Build Experimental Station

Columbia Gulf Transmission Company has been given FPC authorization to construct and operate an ex-

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perimental, remote-control compressor unit at Hampshire, Tenn. The compressor unit is a single 4,000 horsepower, two-cycle, turbo-charged vertical gas engine driving a centrifugal compressor through a speed increaser. Cost of the project is estimated at $1.5 million.

Cities Service Gas Company Lets Contracts on 62 Miles

Cities Service Gas Company has let contracts on 62 miles of 12-, 16- and 30-inch gas lines in Kansas and Missouri.

Vaughn & Taylor will lay 21 miles of 30-inch from Welda to Princeton, Kans., and 25 miles, 12-inch between Hutchinson and Ellsworth, Kans. Trojan Construction Company is building 16 miles of 16-inch in Kansas and Missouri.

O. R. Burden Awarded Contract By Coastal States Gas Producing

O. R. Burden Construction Corporation has been awarded a contract to lay 100 miles of gas gathering lines in South Texas for Coastal States Gas Producing Co.

Burden completed 100 miles of the 270-mile system which is being built to supply gas to Texas Illinois Natural Gas Pipeline Company and Transcontinental Gas Pipe Line Corporation. The system extends from McAllen to Falfurrias, Texas.

Lone Star Constructing 81 Miles of Trunk Lines

Lone Star Gas Company has started work on 81 miles of 10- to 24-inch gas trunk lines in Texas. A total of 48 miles of 20-inch will be laid between Navarro County and Dallas and Parker County and Fort Worth. The 24-inch portion included 5 miles in Dallas County.

Great Lakes Pipe Line Co. Plans $10 Million Expansion

Great Lakes Pipe Line Company plans a 128-mile, 12-inch products line between Iowa City, Iowa, and Middlebury Junction, Ill.

Included in its $10 million expansion program is construction of a new terminal at Marshall, Minn.

PROPOSED PIPE LINE CONSTRUCTION

Here in convenient summary form is Pipe Line Industry's listing of company, line size, length, service, location and project status.

U. S.

Alaska Juneau Gold Mining Co., Los Angeles, 425 miles, 16-inch, gas, Oklahoma City area to St. Louis, planned.

Arkansas Industrial Pipeline Corp., Shreveport, 130 miles, 18-inch, gas, Perla-to-Helena, Ark., $9 million, planned.

Atlantic Seaboard Corp., Charleston, W. Va., 26-miles, 26 and 20-inch, gas, in West Virginia, Virginia and Maryland, authorized.

Cameron Crude Oil Corp., Tulsa, 30 miles, 8-inch, crude, Harper County, Okla., fields to Clark County, Kan., planned.

Coastal States Gas Producing Co., Corpus Christi, Texas, 289 miles, 14 and 18-inch main line and gathering system, McAllen to Falfurrias, Tex., area, and Lopena to La Salle County, $12 million, contract let on 200 miles to O. R. Burden Construction Corp.

60 miles, small diameter, gas gathering line, to tie in with system under construction and extend to Pearsall County, Texas, planned.

Coastal Transmission Corp., Houston, compressor station additions and new lateral lines, $6.2 million, before FPC.

Colorado Interstate Gas Co., Colorado Springs, 140 miles, gas, Green River, Wyo.-to-Provo, Utah; 109 miles, 26-inch, Texas Panhandle to southeastern Colorado; 136 miles, 34-inch, southeastern Colorado-to-Pueblo, Colo.; 107 miles, 30-inch, Pueblo-to-Denver, $91 million, before FPC.

Colorado Oil & Gas Corp., Denver, 400-miles, gas, from Gubik field to Fairbanks, Alaska, planned.

Columbia Gulf Transmission Co., Houston, 12.8 miles, 6 and 20-inch, gas, loop line in Louisiana, $730,000, authorized.

41 miles, 24-inch, gas, loops, Lake Sand Junction to Arath Junction, La., before FPC. 4,000-hp, experimental compressor unit, two-cycle, turbo-charged vertical gas engine driving centrifugal compressor through a speed increaser, $1.5 million, authorized.

Consumers Power Co., 126-miles, 26-inch, gas, main, Michigan-Indiana border to Plymouth, Mich., planned.

East Coast Pipeline Co., 90 miles, 12- to 24-inch, products, Linden, N. J. to Suffolk County, N. Y., $25 million, planned.

El Paso Natural Gas Company, El Paso, 244 miles, 30-inch, Permian-San Juan loops, 108 miles, 20-inch, field feeder lines, before FPC.

69,240 hp in new and existing stations in Texas, Oklahoma, New Mexico and Utah, planned.

400 miles, 34-inch, Salt Lake City, Utah, to California border, planned.

Equitable Gas Company, Pittsburgh, Penn., 11.7 miles of storage pipe line and other facilities, $2,091,430, authorized.

12½-miles, 16-inch, paralleling existing system in Harrison and Marion counties, W. Va., authorized.

Florida Pipeline & Storage Co., 54 miles, products, Port Everglades to Homestead Air Force Base, Fla., planned.

Gillette Pipeline Co., Cheyenne, Wyo., 103 miles, crude, from Dead Horse Creek field to Casper, Wyo., planned.

Great Lakes Pipe Line Company, Kansas City, Mo., 128 miles, 12-inch, products, Iowa City, Iowa and Middleton Junction, Ill., planned.

Great Northern Railway, St. Paul, 400-600 miles, 12-20 inch, crude, from Williston Basin to St. Paul-Minneapolis and Duluth-Superior areas, considered.

Gulf Resources, New York, 125 miles, gas, gathering system, from Lopena area in Zapata County to a point in La Salle County, Texas, planned.

Hope Natural Gas Co., Clarksburg, W. Va., 45 miles, gas, from West Virginia to Pittsburgh area, planned, 20 miles, 24-inch, gas, in Wertzel and Monongalia counties, W. Va., authorized.

Humble Oil & Refining Company, Houston, 116 miles, gas, gathering various sizes, southwest Texas, planned.

Iron Ranges Natural Gas Co., 115 miles, gas, from Itasca and St. Louis counties along route of Mesabi range from Grand Rapids to Aurora, Minn., $5 million, before FPC.

60 miles from Duluth to Silver Bay, Minn., before FPC.

Kaneb Pipe Line Company, 279 miles, 6-inch, products, main line extension and lateral, from Phillipsburg, Kan., to Yankton, S. D., contract let to Williams Bros. Co.

Katy and New York Central Railroads. 2500-mile, 10-12 inch, LPG, from Houston, Texas, to New York, considered.

Michigan Wisconsin Pipe Line Co., Detroit, 311 miles, gas, Marshfield to Appleton, Wis., 66 miles, Illinois, Indiana, and Michigan, 5,280 hp station at Marshfield, $24 million, planned.

Midwestern Gas Transmission Co., Houston, 350 miles, 30-inch, gas, Portland, Tenn., to Joliet, Ill., $50.8 million, contracts let to Grayco Constructors, Inc., Sharman, Allen, Gay & Taylor, Inc., Panama, Inc., Majestic Contractors, Ltd., Bechtel Corp. and Houston Contracting Co., Collins Constructing Co., Pentzien, Inc., Popich Marine Construction, Inc., and Missouri Valley Dredging Co.

Continued on Page 78

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PROPOSED CONSTRUCTION

continued

504 miles, 24-inch, gas, from Minnesota-Canada border near Winnipeg to Marshfield, Wis., $52 million, before FPC.

Mississippi River Transmission Corp., St. Louis, 115 miles, 24-inch, gas, Oran, Mo., to St. Louis County, planned.

Mountain Fuel Supply Co., Salt Lake City, 24 miles, 20-inch, loops in Utah; 5 miles, 8-inch lateral, Utah, before FPC.

New York State Natural Gas Co., Pittsburgh, 30 miles, 20-inch, gas, main, Silver Springs to East Elma, N. Y., $1.6 million, temporary FPC authorization.

43 miles, 20-inch, point west of Kittanning to Luthersburg, Penn, 14 miles, 26-inch, Little Marsh in Chatham Township to Boom station near Lawrenceville, Penn., and additional horsepower at Woodhull, Utica, N. Y., and Preston and Tonkin, Penn., contract let on 14 miles, 26-inch to Williams Bros. Co.

Northern Illinois Gas Company, 140 miles, 24-inch, gas, main line, East Dubuque to Des Plaines, Ill., contract let to Contracting & Material Co.

Northern Natural Gas Company, Omaha, 46 miles, 30-inch, gas, loops, in Iowa, Nebraska, and Kansas; 18-miles, lateral extension, and 6,000 hp additions in Kansas, Nebraska, and Iowa, $8 million, contract let to R. H. Fulton & Co.

57 miles, gas, loops, Nebraska, Iowa, and Kansas, 8,000 hp additions in Kansas and Nebraska, $7.7 million, contract let to R. H. Fulton & Co.

171 miles, main line extensions, 66 miles, main loops, 139 miles, branch lines, 6,000 hp additions, to extend system from Minneapolis to Duluth-Superior area, $25.7 million, before FPC.

46 miles, main line extensions, 191 miles, loops, 1,767 miles, branch lines, and 45,400 additional hp, in Iowa, Minnesota, South Dakota, Nebraska, Wisconsin and Illinois, $76.7 million, before FPC.

Ohio Fuel Gas Co., 65 miles, gas, 4-24-inch main lines, in Belmont, Carroll, Cuyahoga, Fairfield, Logan, Lorain, Marion, Muskingum, Stark and Wayne counties, Ohio, $4.4 million, contract let on 30 miles to Shamrock Construction Co.

Okan Pipeline Company, 28 miles, 4-inch, LPG-natural gasoline, from Mocane plant in Beaver County to Liberal, Kan., station, planned.

Pacific Gas & Electric Co., San Francisco, 296 miles, 36-inch, gas, from Klamath Falls, Ore., to Antioch, Calif., southern section of line from Canada to California, before California Public Utilities Commission.

131 miles, 34-inch, loops, Topock-Milpitas, before FPC.

42 miles, 30-inch, gas, Pittsburg to Irvington, Calif., planned.

Pacific Gas Transmission Co., San Francisco, 614 miles, 36-inch, Kingsgate B.C. to Klamath, Ore., northern section of Canada to California line, before FPC.

Pacific Lighting Gas Supply Co., 128-mile, 34-inch, gas, main line from Topock, Ariz. to Newberry, Calif., authorized.

Pacific Northwest Pipeline Corp., Salt Lake City, 235 miles gas, gathering lines in San Juan Basin, Garmesa, Piceance Creek, and Big Piney Fields, $13.5 million, planned.

65 miles, gas, sales laterals in Washington, $1.5 million, planned.

Pennsylvania Gas Co., Warren, Penn., 38 miles, 8 and 10 inch, gas, in Erie and Warren Counties, Penn., and Chautauqua County, N. Y., $2.6 million, authorized.

Permian Basin Pipeline Company, Omaha, 83 miles, 16-inch, gas, from Pioneer's proposed facilities to Spraberry, Texas, and 3,960 hp compressor station, $5 million, before FPC.

Piedmont Gas Co., Hickory, N. C., 78 miles, 2-8 inch, gas, from connection with Transcontinental Gas Pipe Line to serve customers in North Carolina, $2.6 million, authorized.

Pioneer Gathering System, Inc., Amarillo, Texas, pipe line facilities in Texas costing $3.7 million, before FPC.

Pioneer Natural Gas Co., Amarillo, Texas, 62 miles, 10-inch main, Pampa, Texas, to Canyon, in Randall County, Texas, 20 miles, small diameter, gathering, 4,000 h.p. stations, $4.5 million, planned.

Phillips Petroleum Co., 25 miles, 6 to 20-inch, gas, South Eunice, New Mexico area, planned.

52 miles, 4 to 20-inch, gas, Gaines County, Texas, planned.

44-mile, 6-inch, products line, from Rocky pump stations to Amarillo, Texas, planned.

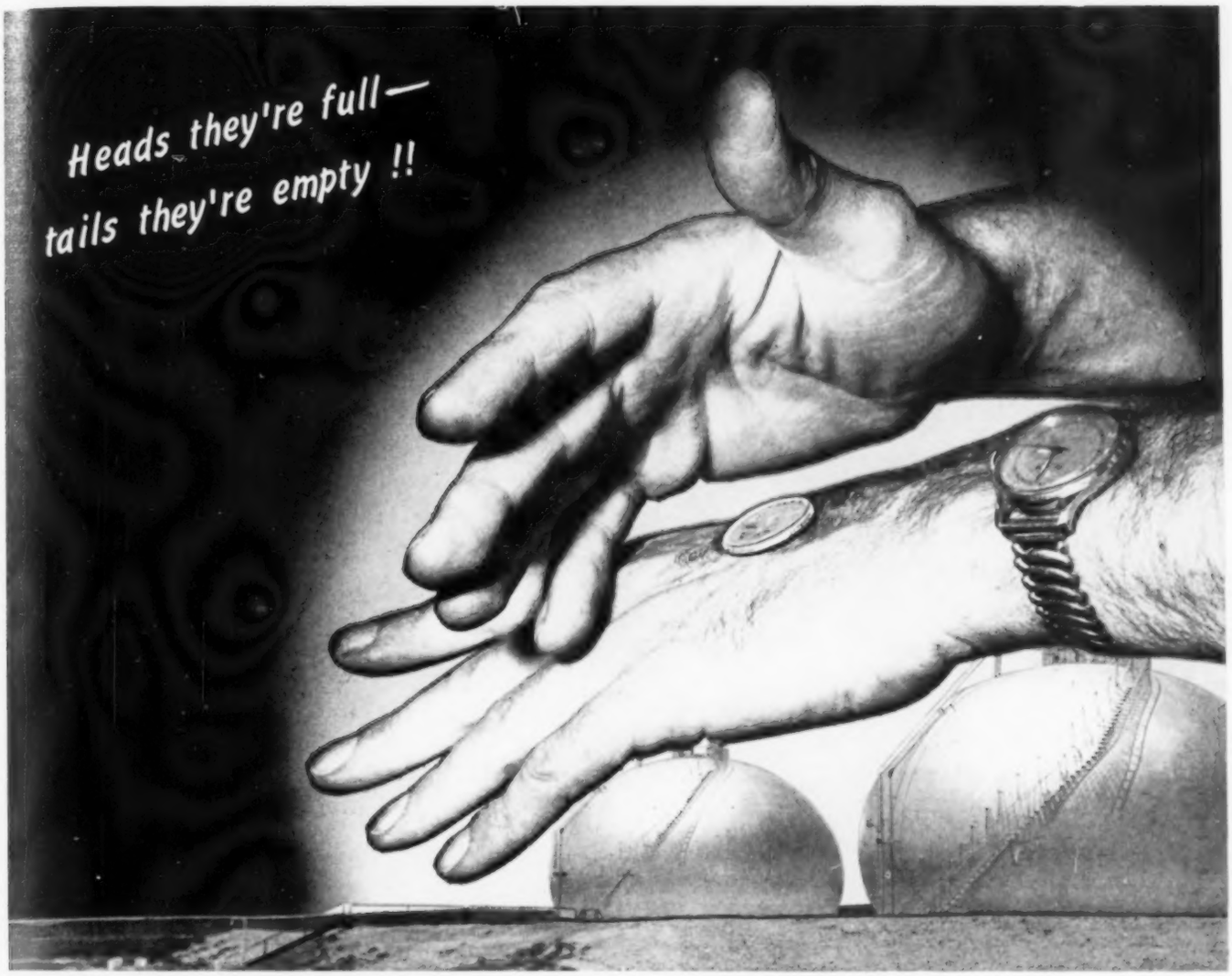
Rio Gas Gathering Co., San Antonio, 97 miles, 3 to 8-inch, gas gathering, South Texas, to supply gas to El Paso Natural Gas Company, planned.

Southern California and Southern Counties Gas Cos., Los Angeles, 200 miles, 34-inch, from Nevada-California border to point near Fullerton, Calif., $44 million, before Public Utilities Commission.

Southern Natural Gas Company, Birmingham, 490 miles, 16-24-inch, loop lines, gas, between Gwinville, Miss., and Wrens Ga; 62 miles, 14-inch, loops, along Atlanta-Macon line; 53 miles, 6⅝ to 14-inch, loops, along various branch lines. 3,140 additional hp at Gallion and Elmore, Ala. and Wrens, Ga. 60 miles, 20-inch, loops, in Louisiana between Franklington and White Castle and South of Toca. Lateral lines south of Gwinville and west to Cranfield field. 8,720 hp added at Franklinton, White Castle, Patterson and Brookhaven, contracts let on 355 miles to Sharman, Allen, Gay & Taylor; Oklahoma Contracting Co.; Harbert Construction Corp.; C. S. LeNoir Construction Co.; and Buchanan Contracting Co.

Tennessee Gas Pipeline Co., Houston, 21 miles, 16-inch, 2 miles, 12¾-inch, gas, Louisiana coast, Vermillion, Blocks 46 and 64, $2.9 million, before FPC.

Continued on Page 80



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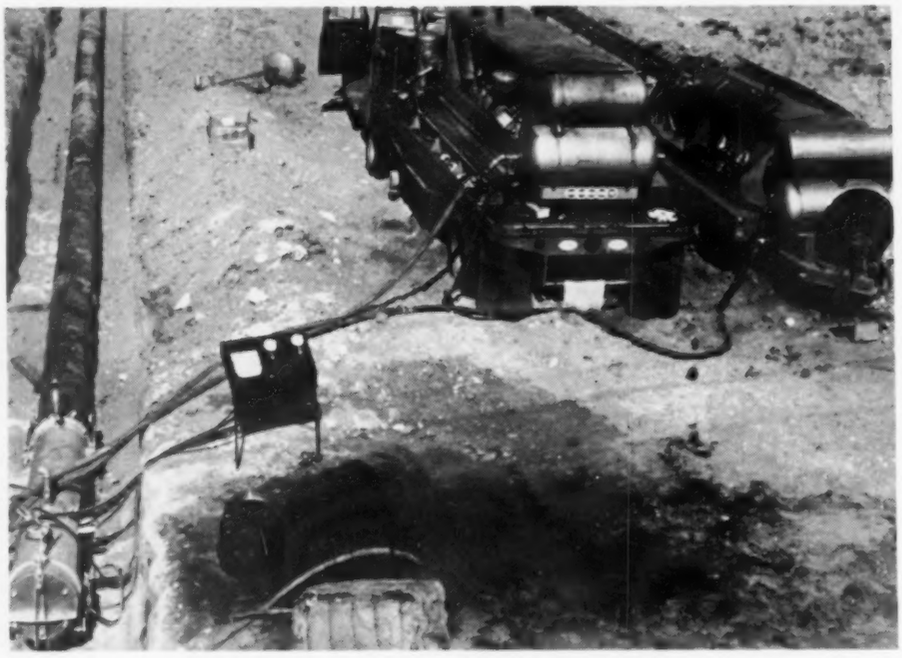

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PROPOSED CONSTRUCTION

continued

158 miles, 36-inch, looping system in Louisiana and Mississippi, to supply Midwestern additional gas at Portland, Tenn., $61.4 million, authorized.

Texas Eastern Transmission Corp., Shreveport, La., 267 miles, 14-30 inch, gas. Louisiana, Mississippi, Pennsylvania and New Jersey, $50 million, before FPC.

141,780 additional horsepower in existing stations, a new 2,200 hp compressor station, in Louisiana, Mississippi, Pennsylvania, Ohio, Kentucky and Tennessee, authorized.

65 miles, gas, Delmont, Penn., to Lambertville, N. J., before FPC.

22 miles, 14-inch, gas, Rayne field to Opelousas station in Louisiana, authorized.

Texas Electric Service Company, Fort Worth, 300 miles, gas, Old Ocean field to Fort Worth, Texas, $25 million, considered.

Texas Gas Gathering Corp., Shreveport, 36.6 miles, gas, gathering system in Rodney Field, Jefferson County, Miss. and from North and South Locust Ridge, Lake St. John Field in Tensas and Concordia parishes, La., $855,413, before FPC.

Texas Gas Transmission Corporation, 246 miles, 26-30-inch, loops, between Eunice, La., and Lebanon, Ohio, 102 miles, supply lines, south Louisiana, and addition of 15,760 hp, $40 million, before FPC.

Texas Illinois Gas Pipeline Company, Chicago, 16,000 additional hp to stations at Lufkin, and Marshall, Texas; Texarkana, Malvern, Searcy, and Biggers, Ark.; Jackson, Mo.; and Hammond. Ill., $3.9 million, before FPC.

860 miles, 30-inch, loops to be constructed 1960-61.

Transcontinental Gas Pipe Line Corp., Houston. 149 miles, 36-inch, main loops, 34 miles, 20, 24-inch gathering, compressor stations at Nueces County, Texas and St. Helena Parish, La., additional hp in eight stations, $51 million, before FPC.

Transwestern Pipeline Company, Houston, 1,305 miles, 24- and 30-inch, gas, main line, from West Texas and Oklahoma-Texas Panhandle area to Topock, Ariz., $193 million, before FPC.

Trunkline Gas Company, Houston, 204 miles, 26-inch, gas, main line from Tuscola, Ill., to Michigan-Indiana border; 464 miles, 30-inch loops between Longville, La., and Tuscola and 45 miles, 24-inch, in Texas, 183 miles gathering, Louisiana, 3000 additional hp at Longville station, $81.5 million, contracts let to Western Pipe Line, Inc., Engineers Limited Pipeline Co., C. S. Lenoir, Sam Carline, Inc., Panama, Inc., H. H. Null, Sharman, Allen, Gay & Taylor, Grayco Contractors, Contracting & Material Co., and Panama-Williams.

Underground Storage & Exploration, Upper Darby, Penn., 394 miles, 12-inch LPG, from Moundsville, W. Va. to Newark, N. J., $9 million, approved.

95 miles, 6-8 inch, laterals to Mauch Chunk, Penn., and to Philadelphia, planned.

Continued on Page 82

COOL LIQUIDS OR GASES, condense vapors with TRANE Fluid Coolers, using air as the cooling medium. Unit shown is vertical discharge. Horizontal types also available—both in induced and forced draft arrangements.

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- **Lower operating costs.** Equipment needs only periodic cleaning of fin-tube surface. No need for special crews, maintenance facilities or spare parts. And TRANE Fluid Coolers have a life expectancy of 15-20 years—compared with 7-10 years for cooling towers.
- **Superior performance.** TRANE Coolers available with Admiralty stainless and carbon steel tubing to meet the most exacting specifications. Units are now in use in Canada and Bermuda—meeting extreme weather conditions. They also solve the problem of corrosion caused by salt-air atmosphere.

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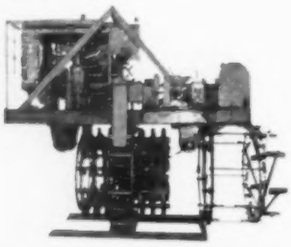
It is powered by an International U-9 self-starting engine and uses the Ramsey transmission. Engine exhaust is utilized to heat primer tank.



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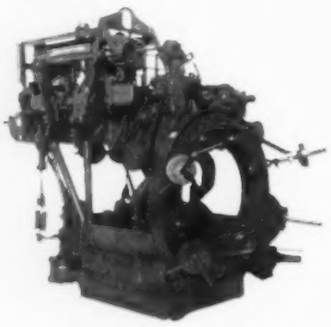

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PROPOSED CONSTRUCTION

continued

United Fuel Gas Company, Charleston, W. Va., 18 miles, 26-inch, gas, Kanawha County, W. Va., $2.5 million, contract let to Engineers Limited Pipeline Company.

Valley Gas Transmission, Inc., Houston, 160 miles, 3 to 8-inch, gas, gathering, in Hidalgo, Brooks, Starr and Jim Wells Counties, Texas, $15 million, before FPC.

Wilcox Crude Oil Corp., Shreveport, La., 20 miles, crude line in east central Louisiana, $500,000, planned.

International

ACT Oils, Ltd., Montreal, 400 miles, crude, Dawson Creek, B. C., to Bella Coola, B. C., before B. C. government.

Alaska-Yukon Refiners and Distributors, Ltd., Edmonton, Alta., 150 miles, products, serving Alaska and Yukon territory, $3.5 million, planned.

Alberta Natural Gas Company (Jointly owned by Westcoast Transmission Co. and Alberta & Southern Gas Co. Ltd.) 110 miles, 36-inch, gas, Alberta border to British Columbia-Idaho border, supply gas to Pacific Gas & Electric Co., $40 million, planned.

Arab League Oil Committee, large diameter crude line from Persian Gulf to Mediterranean Coast, $500 million, considered.

Aurine Alps Railway & Pipeline, 200 miles, crude, Venice to Munich, Germany, considered.

Bituminous Oil Pipeline Co., Calgary, 250 miles, crude, from Athabasca tar sand plant in northeastern Alberta to Edmonton, approved.

Burmah Oil Co., Ltd., 850 miles, crude, 20 inch, from Nahorkatiya to Calcutta, India, planned.

Cartier Gas Corp. (St. Maurice Gas, Inc., and Consumers Gas Co., Toronto), 170 miles, gas, Montreal to Quebec City, planned.

Colombian Petroleum Company, 68 miles, 12-inch, crude, Cicuco field to Covenas, planned.

Consolidated Gathering Systems, Ltd., Calgary, 198 miles, crude, Sturgeon field to Edmonton, planned.

Creole Petroleum Co., 44 miles, 12-30-inch, gas, Bachaquero to Tia Juana, Venezuela, planned.

Development and Resources Corp., 70 miles, 8 inch, gas, from Agha Jari oil field to Ahwaz, Iran, planned.

Entre Nazionali Idrocarburi, Rome, Italy, crude, from Qum field in Iran to the Mediterranean Sea, considered.

Foothills Pipe Line, Ltd., 500 miles, 12 to 16-inch, LPG, from Alberta to Pacific Coast, $80 million, considered.

Gibson Crude Oil Purchasing Co. Ltd., 170 miles, crude, Milligan Creek, B. C. to Grande Prairie, Alta., planned.

Hydrocarbons Pipeline, Ltd., Winnipeg, Manitoba, 880 miles, 6-8 inch, product., from Edmonton to Winnipeg, $35 million, partial authorization.

Independent Pipe Line Co., 2,019 mile, 34-36-inch, crude, Edmonton to Montreal, 23,000 pump horsepower, $395 million, before Borden Commission.

Interprovincial Pipe Line Company, 350-mile extension from Toronto to Montreal, looping line from Edmonton to Toronto, crude, $240 million, considered.

6,150 hp pump station at Iron River, Mich., and 4,450 hp addition at Edmonton, Alta., $2 million, planned.

Iraq Petroleum Company, 80 miles, 30-32-inch, crude, loop line, Rumaila field to Fao, Iraq, planned.

Island Transmission Company Limited, Nanaimo, B.C., 25 miles, 10-inch, gas, from point near Vancouver, B.C. to Vancouver Island, 67 miles, 10-inch, laterals to Victoria and Nanaimo, B.C., $14 million, planned.

Mid-Continent Pipe Lines, Ltd., 1500-mile, 30-inch crude, Edmonton to Chicago, planned.

NATO, 211 miles, crude, 6-inch, between Malatya-Cetinkaya-Erzincan, Turkey, $6 million, bids asked.

National Iranian Oil Co., 146 miles, 6 inch, crude, from Azna to Isfahan, Iran, $5 million, planned.

1000 miles, 38 inch, crude, from central Iran to the Turkish Mediterranean coast, considered.

Peace River Oil Pipe Line Co., Ltd., 70-mile, crude, Swan Hills to Iosegun Junction, approved.

230 miles, 8-inch, crude gathering, from fields in northeast British Columbia to Dawson Creek, B. C., and Grande Prairie, Alta., and to existing lines at Sturgeon Lake, $2.5 million, planned.

Pembina Pipe Line, Ltd., Edmonton, 1,200 miles, LPG, from Alberta gas fields to eastern Canada, planned.

Petroleos Mexicanos, 38 miles, 4 inch, products, from Mexico City to Toluca, $500,000 planned.

126 miles, 4, 6 and 8 inch, products, from Mexico City to Cuernavaca and Puebla, $2.5 million, planned.

214 miles, products, Monterrey to Torreon, $6.5 million, planned.

Pipelines of Puerto Rico, Inc., 95 miles, 8-inch, products, Penuelas to San Juan, Puerto Rico, planned.

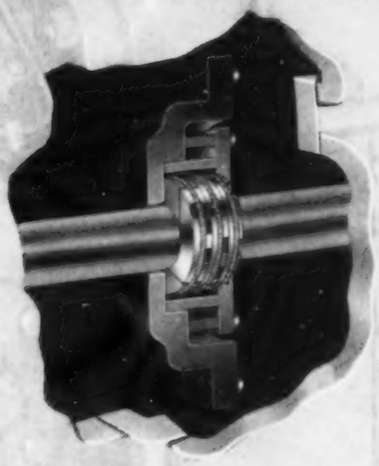
Sociedad Nacional de Oleoductor, 75 miles, crude, from Santiago-to-Valparaiso, $3 million, planned.

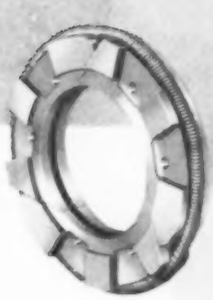
Societa Nazionale Metanodotti, 250 miles, 18-inch, crude and products, Genoa to Milan-Cremona-Torino, Italy, and Geneva, Switzerland, considered.

Societe d'Etude du Pipe Line Sud-European, Paris, 419 miles, 30-inch, crude port of Lavera to Strasbourg, with lateral extending 40 miles to Karlsruhe Germany, approved by French cabinet

Continued on Page 84

KEEP OIL WHERE IT BELONGS...





Garlock metal scraper rings prevent leakage, excessive oil consumption

Garlock Style #4400 Scraper Rings allow an exact coating of oil on the shaft . . . return excess to the crankcase. Design benefits are many—*two* scraping edges add greater scraping efficiency, special drain holes relieve pressure buildup, balanced bearing areas prevent "tipping" of the ring.

All rings have a surface finish of less than 10 micro-inches . . . are flat within light band readings . . . come in cast iron, bronze, barium bronze, babbitt, carbon, TEFLON*.

Scraper rings are part of a complete line of Garlock Metal Packings for positive sealing on pumps, engines, and compressors. Designed for the toughest applications, Garlock metal packings are presently handling temperatures as high as +800°F and pressures to 35,000 psi.

Metal packings and scraper rings are more of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. Consult your local Garlock representative for more information, or write

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Lincoln WELDYNAMICS

NEWS ABOUT ARC WELDING AT WORK CUTTING COSTS

SPECIAL ROOT PASS ELECTRODE MAKES PIPE WELDING EASIER

The few contractors who have switched electrodes from their old standby Fleetweld 5 to its newer twin brother Fleetweld 5-P, designed especially for pipeline welding, are reporting that the exceptional operating characteristics of Fleetweld 5-P electrodes make weldor qualification almost automatic.

The softer, steadier arc makes acceptable welds easier to make. Reduces "windows", eliminates "wagon tracks". One pipeliner says that where 15% to 20% of men trying to qualify as pipeline weldors used to fail, now more than 95% pass when they use Fleetweld 5-P.

Another contractor claims x-ray quality with Fleetweld 5-P is so much better that cutouts have been reduced 50%.

Although some highly skilled old timers will always prefer to use Fleetweld 5, many are finding Fleetweld 5-P even better. Have you tried Fleetweld 5-P yet?

THE LINCOLN ELECTRIC COMPANY

Dept. 5108 • Cleveland 17, Ohio

The World's Largest Manufacturer of Arc Welding Equipment

PROPOSED CONSTRUCTION

continued

Sui Gas Transmission Co., Multan, Punjab, India, 145 miles, 8-inch, gas, from Sylhet to Dacca, East Pakistan, $9 million, considered.

130 miles, 16-inch, gas, main line, Multan to Lyallpur, planned.

Trans-Canada Pipe Lines Limited, Toronto, compressor stations at Ignace, Geraldton and Hearst, Northern Ontario, and Maple, north of Toronto, $15.5 million, planned.

Trans-Prairie Pipelines, Ltd., Edmonton, crude line, from Weyburn field to Regina-Moose Jaw areas, $5 million, considered.

Crude line from Milligan Creek area to Dawson Creek and Fort St. John refineries, planned.

Union Gas Company of Canada Limited, 45 miles, 8-inch, gas, main, Stratford to Goderich, Ontario; 10-miles, 8-inch, main, to Amhertburg; 10-miles, 12-inch, lateral, Galt to Brantford, planned.

Westcoast Transmission Company, Ltd., 174 miles, 30-inch, gas, Savanna Creek gas field, Alberta, to British Columbian border, $45 million, planned.

Williams-McWilliams Industries, Inc., New York, 441 miles, 6-inch, crude, Villa Montes, Bolivia to Villa Hayes, Paraguay, considered.

Yacimientos Petroliferos Fiscales, Buenos Aires, Argentina, 621 miles, 12-inch, products, Mendoza to San Lorenzo, Argentina, $19 million, planned.

281 miles, 12¾ inch, crude, Pichanal to San Miguel Tucuman to Techint, S. A., planned.

450 miles, 16-inch, crude, from Neuquen Province to Bahia Blanca, planned.

Construction To Begin On 720-Mile Line in India

Construction on India's 720-mile crude line will begin soon. The line which will be built by Burmah Oil Company, will extend from Nahorkatya field to refineries planned at Guahati, Assam, Barauni and Bihar.

Pan American International Building 84-Mile Crude Line

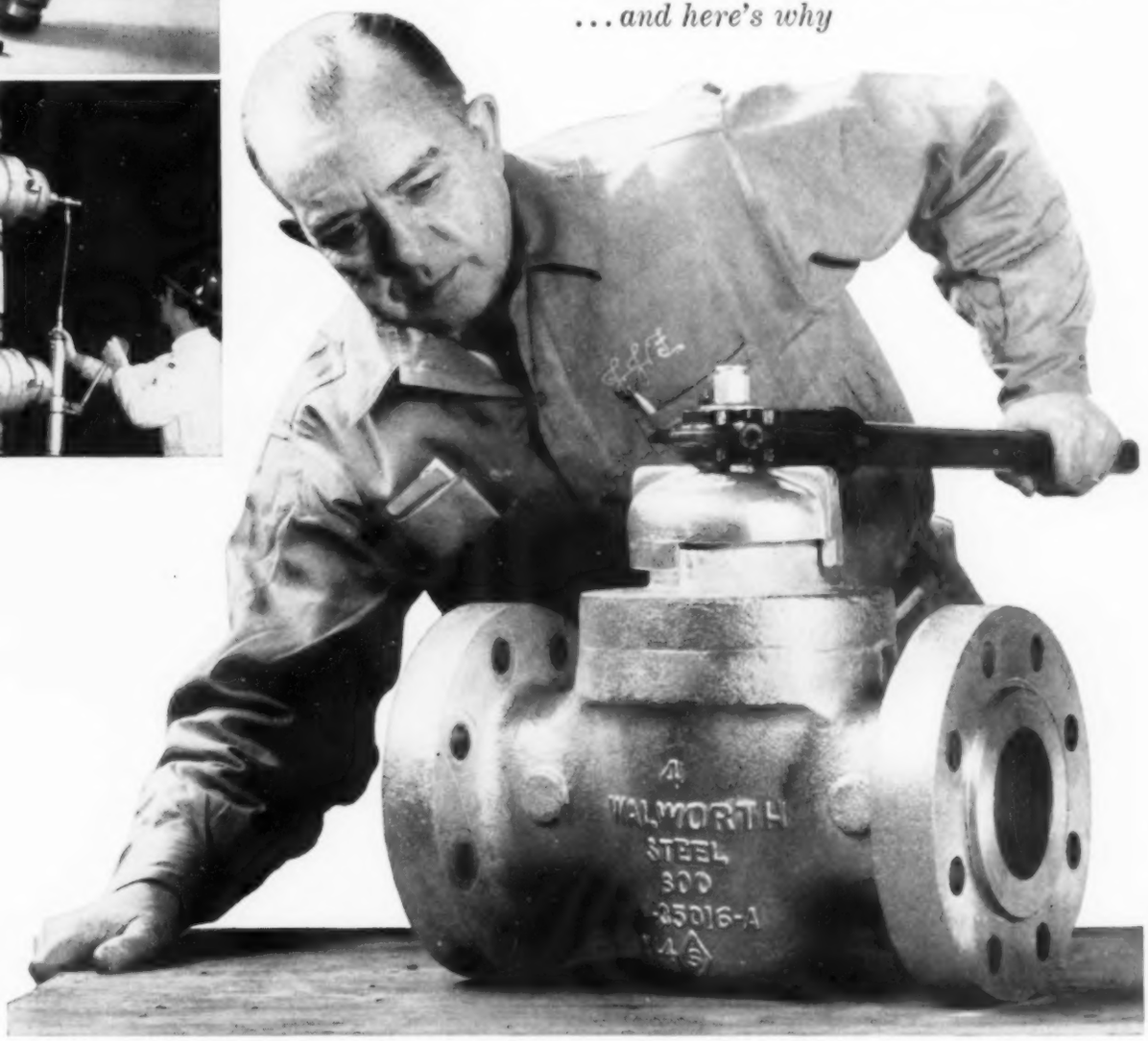
Pan American International Oil Company has started work on an 84-mile crude line from its Comodoro Rivadavia field to Patagonian Atlantic coast. The 12- to 14-inch line will be completed in January with an initial capacity of 12,600 bpd.

For more data on advertised products, use Readers' Service Cards, last page.

the **WALWORTH CUSTOMER**
wants a quick operating,
sure, tight valve. He chooses a

WALWORTH LUBRICATED PLUG VALVE

... and here's why



When the Walworth Customer has to decide on a valve that will close fast and easily, he wants to know HOW fast... HOW easily. Tight closure? Of course. But can the valve be serviced under pressure? Yes. Still, he tries one himself.

In the Walworth Lubricated Plug Valve he finds 100% tight closure because it is lubricant-sealed against leakage. He finds it opens or closes with a quarter turn. Then, and only then, he's ready to buy. If that's the way you like to buy valves, we want you, too, for a Walworth Customer. For details on all types and ratings of Walworth Lubricated Plug Valves, ask your Walworth Distributor.

Or write **WALWORTH** *750 Third Avenue, New York 17, N. Y.*
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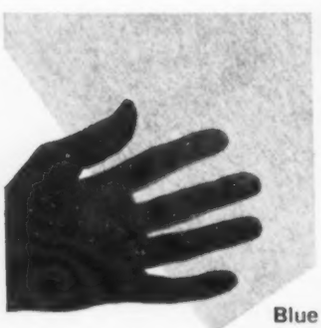
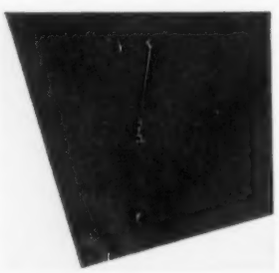
Blue Flag Fiber Glass

give you





Blue Flag Wrap (left), has uniform porosity for quick bleed-through of enamel. **J-M Asbestos Felt (right),** saturated with coal tar or asphalt, provides a tough outer shell...3 types for field or mill wrapping.

Buyers of pipeline wraps and tapes are now served by an enlarged staff of Johns-Manville sales and technical personnel operating out of 56 sales offices . . . by expanded distribution facilities . . . by the addition of 7 strategically located plants . . . and by expanded research and product development laboratories. For further information, write Johns-Manville, Box 158, New York 16, N.Y. In Canada, Port Credit, Ontario.

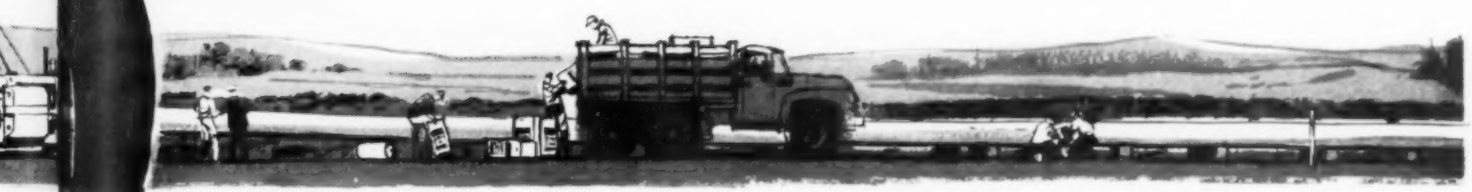
pipeline protection

and Johns-Manville Asbestos Felt join to one responsibility for a better job

...1 For enamel reinforcement

J-M Blue Flag® Wrap—specially formulated from borosilicate type fiber glass—strengthens pipeline enamels the way steel rods reinforce concrete. It reduces cracking and deformation of the enamel. The inorganic fiber glass can't rot, decay or absorb moisture in the ground . . . will add years of protective life to pipeline enamels.

The uniform porosity of Blue Flag allows the enamel to bleed through quickly. It minimizes holidays and helps form an evenly distributed coating with high resistance to soil stresses.



...2 For a tough outer shell

J-M Asbestos Felts, made of fibrous stone, provide a tough, durable outer shell. During the manufacture—natural asbestos mineral fibers are felted, then impregnated with coal tar or asphalt saturant to provide, literally, "a flexible covering of stone."

This outer shell of asbestos protects the enamel against soil stress, earth movement and rock pressures. It resists damage from handling, backfilling, other hazards of installation.

Inert, inorganic asbestos fiber has been uniquely inured by nature over millions of years against rot or decay. Asbestos comes from the ground, is always at home in the ground.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

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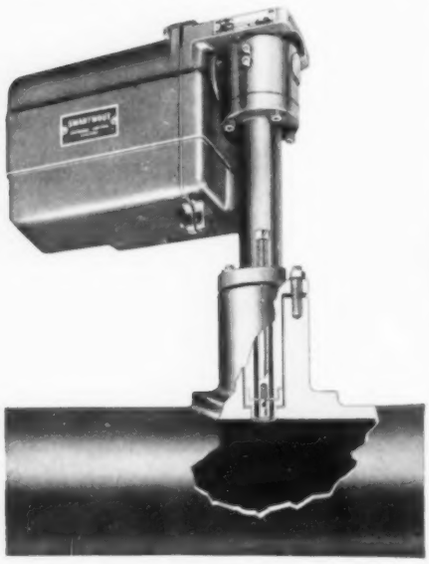
Great things are happening in AutroniC® Control

TOUGH PROBLEMS ARE NO PROBLEM



FOR THIS FOOLPROOF, FOUL-PROOF PRESSURE TRANSMITTER

Here is a primary sensing element for those tough jobs you'd like to forget. Mounted right on the process pipeline or tank, the Swartwout Flush Diaphragm Pressure Transmitter will effortlessly measure pressure or liquid level of polymers, slurries, asphalts, viscous fluids, molten metals and other difficult media. No stagnant pressure lines, no steam jacketing necessary . . . the stainless steel transmitter diaphragm fits flush with the inside of the vessel.

A friction-free linkage multiplies diaphragm motion and actuates the core of a differential transformer to produce a 0-0.5V AC signal for any Swartwout AutroniC indicator, recorder or controller. Sensitivity is better than 0.005%, reproducibility 0.1%, accuracy 1.0%.

The Flush Diaphragm Pressure Transmitter is just one unit in the constantly-growing AutroniC family of electronic instrumentation . . . a family that includes all necessary components for complete electronic control of any process parameter.

For details on the Flush Diaphragm Pressure Transmitter, request Bulletins A-713 and A-718. The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

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S-A. 1958

What's Happening

among MEN in the INDUSTRY

J. G. Dickinson

Keith Bentz

C. B. Randall

F. P. Burns

Natural Gas Pipeline Company of America announces the election of a senior vice president, three vice presidents and an assistant secretary.

J. G. Dickinson is the new senior vice president; **Keith Bentz, C. B. Randall,** and **F. P. Burns** have been named vice presidents and **J. M. Durrett** becomes assistant secretary.

Dickinson has been supervising production activities from the Amarillo, Texas, office since 1930 and has been a vice president since 1949. Bentz, who joined the company in 1938, has been assistant vice president of operations. Joining NGPL in 1934, Burns was made assistant vice president of production in 1953. Randall has been with the company since 1931 and was director of tax and insurance. Durrett joined NGPL in 1930.

F. J. Stubbs, assistant general manager of **Interprovincial Pipe Line Company,** has been named assistant to the president, **T. S. Johnson.**

Before coming to Interprovincial, Stubbs was associated with Imperial Oil Limited for 17 years. His headquarters will be relocated from Edmonton to Toronto, Canada.

New York State Natural Gas Corporation has appointed **J. A. Lockard** superintendent of warehousing with headquarters in Pittsburgh.

Lockard joined the company in 1953 in charge of material control and in 1958 he was transferred to the Production Department.

Dan L. Gardner has joined **Northern Natural Gas Producing Company** as chief production engineer. Formerly he was with Crescent Petroleum Corporation.

John J. Ashley has been appointed district superintendent for **Service Pipe Line Company's** Joliet, Ill., district. Formerly superintendent of the company's Pauls Valley district in Oklahoma, Ashley succeeds **J. W. McFarland,** who retired.

Shell Pipe Line Corporation has named **Clarke L. Coldren** manager of the technical development laboratory in Houston. He has been with Shell since 1952 and had been an engineer in the Mechanical and Electrical Engineering Department for Shell Development Company's Emeryville, Calif., Research Center.

Hy Yellin, formerly chief engineer with **Pipe Line Engineering Company,** has opened his own consulting-engineering office in Dallas. Yellin joined Pipe Line Engineering in 1949 and worked on a number of major pipe line projects.

John Noble, president of the **Trans-Arabian Pipe Line Company,** has been elected to the board of directors of the **Arabian American Oil Company.**

Noble served as associate general counsel of Aramco prior to assuming the presidency of Tapline in 1956. His headquarters will continue to be in Beirut, Lebanon.

W. K. Warren has been elected chairman of the board for **Transwestern Pipeline Company** and **John R. McMillan** has been named vice chairman. Warren is chairman of the board and chief executive officer of Warren Petroleum Corporation and a director and member of the executive committee of Gulf Oil Corporation. McMillan is president of Monterey Oil Company. **J. R. Butler** was named chairman of the executive committee and secretary-treasurer of the company. **W. H. Simmons** was appointed assistant treasurer and secretary, and **Mrs. Lorrain Stratton** was named assistant secretary.

W. K. Warren

H. D. McHenry, vice president, secretary and general counsel of **Southern Natural Gas Company,** has been elected executive vice president by the board of directors.

He has been associated with Southern Natural since 1936. Prior to moving to Birmingham, Ala., in 1941, he was employed in the New York office.

New York State Natural Gas Corporation has announced the retirement of **Paul R. Steele** after 35 years service with affiliated companies of **Consolidated Natural Gas Company.** He had been with New York State since 1951. Before coming to **Peoples Natural Gas Company** in 1941, he worked for **Hope Natural Gas Company.**

R. M. Hoffer

J. J. Trebilcott

Michigan Wisconsin Pipe Line Company announces the election of two vice presidents, **James J. Trebilcott** and **Robert M. Hoffer.** Trebilcott also was named to the board of directors and reappointed manager of operations.

Hoffer was elected a vice president of the **American Louisiana Pipe Line Company.** He has served as controller of the affiliated pipe line systems since 1957, and was reappointed to those posts.

Trebilcott joined Michigan Wisconsin in 1948 and served as administrative assistant to the vice president in charge of operations, assistant manager of operations and was named manager of operations in 1958. Hoffer was a partner in the accounting firm of Arthur Anderson & Co. before joining the pipe line companies.

Fred A. Crane, superintendent, Right of Way and Claims Department, **Sinclair Pipe Line Company,** was elected national chairman of the **American Right of Way Association** at the annual meeting of the board of directors held in St. Louis.

Transcontinental Gas Pipe Line Corporation has named **A. E. Hamalainen** superintendent of compressor station No. 5 at Eunice, La. Before his new appointment he had been superintendent of the Chatham, Va., station.

H. E. Melton has been promoted from repair foreman to superintendent of station No. 36 at Chatham.

Dan L. Mayer has been promoted to manager of **Phillips Petroleum Company's** Natural Gas Department. He succeeds **R. B. Stewart,** who recently was promoted to vice president.

Mayer has been with Phillips since 1932. He became general superintendent of Natural Gas Department in 1951 and assistant manager of the department in 1956.

R. C. Ledford has been named a vice-president, international operations, for **Collins Construction Company** with headquarters in Houston. Ledford had been vice president of Marine Gathering Company.

R. C. Ledford

Prior to joining Marine Gathering, he was associated with Phillips Petroleum Company, acted as design engineer on magnesium and gasoline plant construction work for Dow Chemical Company, and was chief engineer for the Barber Asphalt Corporation.

B. J. Davis

G. E. Anderson

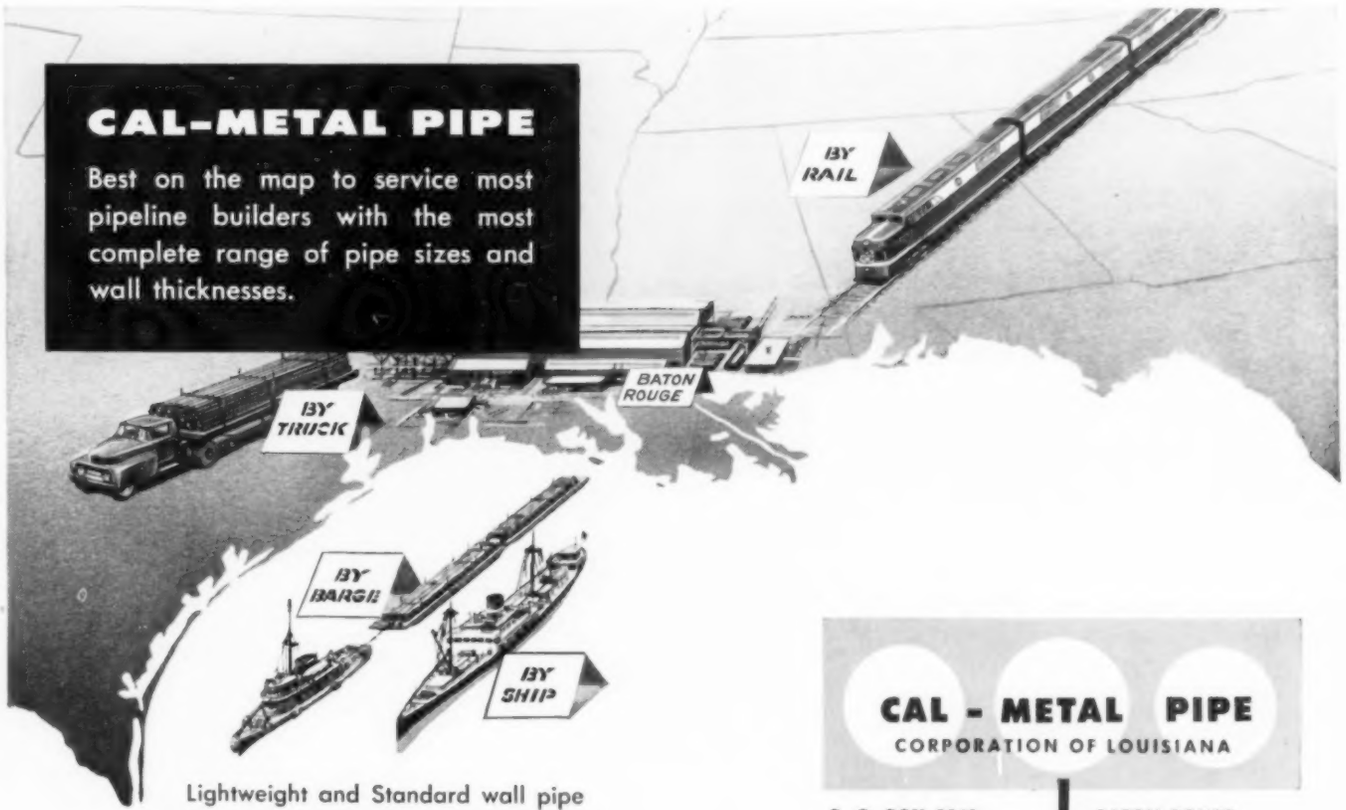
A Canadian construction firm, **Daco Construction, Limited,** has been formed with offices in Vancouver, B. C. The company plans to build small pipe lines, distribution systems and right of way clearing.

Officers include **B. J. Davis,** president; **G. E. Anderson,** vice president, secretary and treasurer, and **Albert Hughes,** director.

D. Michael Curran has formed his own construction firm and has formed an overseas organization with **H. C. Price** of **H. C. Price Company** for foreign pipe line work.

Formerly president of M. J. Crose Manufacturing Co., and senior vice president with Williams Brothers Company, Curran is president of **Curran & Company,** recently formed in Great Falls, Mont., for construction in Canada and in the Northwest United States.

Burt T. Mast, chief engineer for **Trunkline Gas Company,** has been elected president of the Houston Engineering and Scientific Society. Mast served as a vice president for the society last year.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Lightweight and Standard wall pipe
Sizes 4" through 42" mill rolled,
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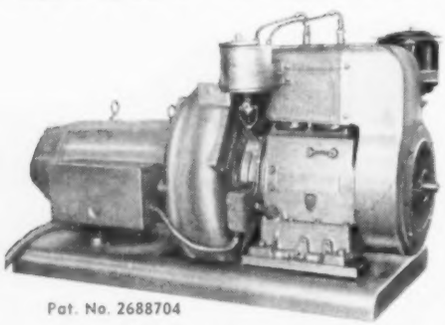
NO DROOP DROP or BREAK

AMAZING U.S. MICRO-POWER



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. . . the slightest drop in voltage. Actually *anticipates* power failure BEFORE voltage drops below a usable level.

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. . . UP TO $300 PER MILE on new Micro Wave installations. Just one compact Micro-Power Unit replaces a costly array of complicated equipment.

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UNITED STATES MOTORS CORPORATION

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J. R. Whatley

Theodore Gupton

James R. Whatley has been elected vice president finance and **Theodore Gupton** vice president, engineering, for **Pipe Line Technologists, Inc. Michael G. Shoup was** appointed controller.

Whatley joined the company in 1955 as controller. Previously he had been with the accounting firm of Peat, Marwick & Company, and with Humble Oil & Refining Company. Gupton came to Pipe Line Technologists in 1958. Formerly he was district sales manager in charge of Alco Products, Inc. Shoup joined the firm in 1956 as chief accountant.

WHO'S MEETING WHERE

July

University of Michigan, short course on underground storage of natural gas, Ann Arbor, Mich., July 6-15.

University of Michigan, research conference on underground storage of natural gas, Ann Arbor, Mich., July 16-17.

August

Society of Automotive Engineers, national west coast meeting, Hotel Georgia, Vancouver, B. C., August 10-13.

AIEE, annual petroleum industry conference, Wilton Hotel, Long Beach, Calif., August 23-26.

West Virginia University, annual Appalachian gas measurement short course, Morgantown, W. Va., August 24-26.

Mid-West Gas Association gas school and conference, Iowa State College, Ames, Iowa, August 26-28.

September

Pacific Coast Gas Association, annual meeting, Ambassador Hotel, Los Angeles, Sept. 9-11.

NGAA, Rocky Mountain Regional meeting, Wyoming-Gladstone Hotel, Casper, Wyo., Sept. 17.

ASME, petroleum mechanical engineering conference, Rice Hotel, Houston, September 20-23.

ISA, 14th annual instrument-automation conference and exhibit, International Amphitheatre, Chicago, Sept. 21-25.

American Welding Society, fall meeting, Sheraton-Cadillac Hotel, Detroit, Sept. 28-Oct. 1.

NACE, western region conference, Bakersfield Inn, Bakersfield, Calif., Sept. 29-Oct. 1.

October

NACE, southeast region, Robert Meyer Hotel, Jacksonville, Fla., Oct. 1-2.

NACE, northeast region, Lord Baltimore Hotel, Baltimore, Md., Oct. 5-8.

AGA, 41st annual convention, Conrad Hilton Hotel, Chicago, Oct. 5-7.

California Natural Gasoline Association, fall meeting, Huntington-Sheraton Hotel, Pasadena, Calif., Oct. 8-9.

NACE, south central region, Cosmopolitan Hotel, Denver, Oct. 12-15.

ASCE, pipe line division, annual meeting, Washington, D. C., Oct. 19-23.

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Ask your Representative about the entirely NEW concept in Cathodic Protection! The Good-All

"AMP-O-MATIC"

Rectifier. Just set it and forget it . . . the Amp-O-Matic automatically ADJUSTS OUTPUT ITSELF!

GOOD-ALL ELECTRIC MFG. CO.

OGALLALA, NEBRASKA

CAPACITY

SACHSE ELECTRIC INC.

BATON ROUGE LA.

NOW! THE BOLD ADVANCE IN VALVE DESIGN

W-K-M's NEW *Pressure Sealing* GATE VALVE

Tested and Proved in the Toughest Services!

Enthusiastic, completely favorable user reports affirm the superior quality and effortless operation of W-K-M's new Pressure Sealing Gate Valve. "Handles all the sludge in a gas blowout line easily – works better than any valve we've used," states a petroleum engineer. A foreman says,"... easiest operating valve I ever saw ... smoothest working valve made." Similar reports covering many other services are in W-K-M's engineering test data files.

Turn the page to see the design features that make this unique valve so outstanding

ASA 150 lb. (275 cwp) and ASA 300 lb. (720 cwp)

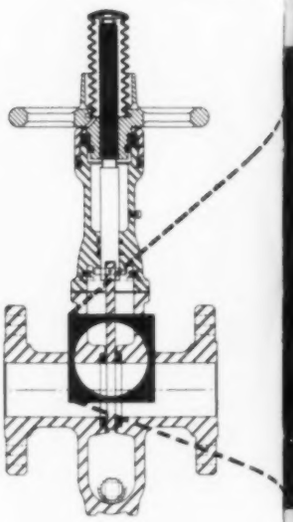
ANOTHER OUTSTANDING PRODUCT OF **W-K-M**

DIVISION OF ACF INDUSTRIES INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

Floating

Combination indicator and stem protector. A neoprene rubber bellows compounded to a bright yellow color for long-range visibility—extends above the handwheel when the valve is open; retracts into the handwheel when the valve is closed. It also protects the stem threads from dirt and corrosion.

The stem is heat-treated, hardened stainless steel, with double lead Acme threads for fast operation.



Anti-friction bearings support the operation of the stem nut and handwheel. This feature contributes to easier operation and longer, trouble-free life.

A grease fitting is provided in the bonnet to allow lubrication of the stem threads and bearings.

The bonnet-body connection is a rigid bolted construction with a rubber primary seal and metal-to-metal secondary seal. This seal eliminates the high bolt loads required by conventional bolted connections.

"O" rings are used for stem packing. They provide an ideal seal and eliminate repacking procedure required with conventional valves.

The gate is made of steel, hard-chrome-plated for protection against wear and corrosion.

The floating seats are unique in design. Each seat consists of two kinds of rubber, formulated to W-K-M's specifications, molded to a hardened steel insert. There is a full bore opening, the same diameter as the port, through the insert.

Soft rubber, for sealing, is on the back side of each seat. Tougher, abrasive-resistant rubber, to resist wear, is on the front or gate side. The steel insert is ringed with holes. Pressure forces the soft rubber through these holes, reinforcing the tough rubber and compensating for any wear.

The body and bonnet are steel.

The port is round, the same diameter as the I. D. of the pipe.

Through-conduit construction permits maximum flow, minimum turbulence and pressure drop.

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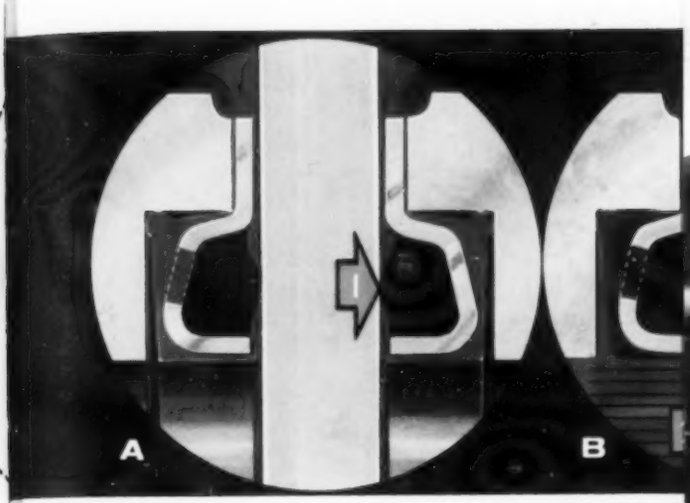
Seats Gi BOLD ADVANCE IN VALVE DESIGN



Line Pressure S

Illustration A shows the gate in the closed position as it forms a primary seal (1) with the raised ring of tough, firm rubber on the face of each seat.

As line pressure (2) is applied to the valve in Illustration B, the gate is forced against the rubber ring on the downstream seat (3) and compresses it until the gate rests against the hardened steel insert (4). This provides a tight seal between the gate and the rubber on the face of the seat, and a secondary metal-to-metal seal. The action also forces the soft rubber on the back of the seat tightly into its recess (5) and prevents any downstream flow at this point.

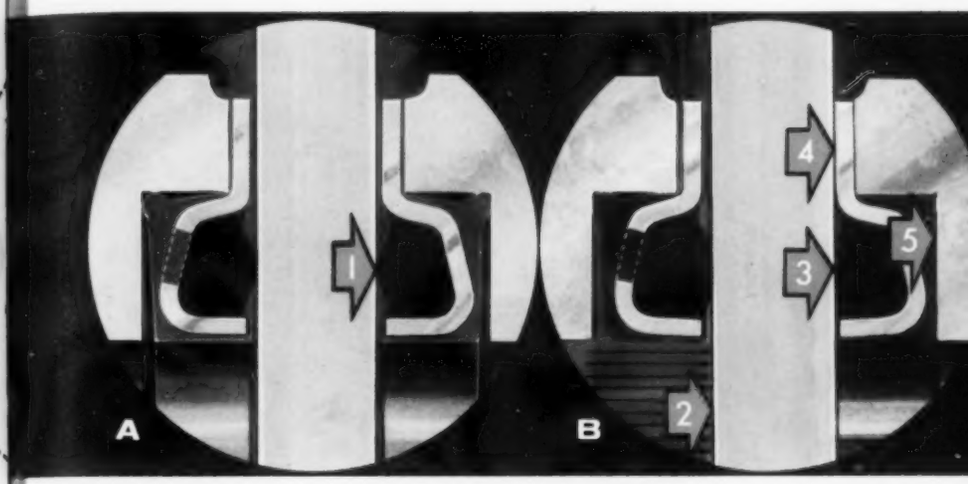
This superior valve gives you all these advantages:

- Tight seal both up and downstream in open and closed position
- Full bore, through-conduit
- Non-lubricated
- Seats automatically adjust for wear
- Automatic relief of excessive body pressure
- Ideal for abrasive ladings, light gases, volatile liquids up to 250° F.
- Easy to overhaul on the line

W-K-M's NEW *Pressure Sealing* GATE VALVE

'S *Creative Engineering*

Seats Give P



Line Pressure Seals th

Illustration A shows the gate in the closed position as it forms a primary seal (1) with the raised ring of tough, firm rubber on the face of each seat.

As line pressure (2) is applied to the valve in Illustration B, the gate is forced against the rubber ring on the downstream seat (3) and compresses it until the gate rests against the hardened steel insert (4). This provides a tight seal between the gate and the rubber on the face of the seat, and a secondary metal-to-metal seal. The action also forces the soft rubber on the back of the seat tightly into its recess (5) and prevents any downstream flow at this point. This double action downstream seal.

The upstream s C is caused by line into the seat rece seat (6), thereby the gate (7). This achieve a positive s the ring of tough r seat. At the same ti rubber on the back seal with the seat

These double-a vide tight, positive downstream.

W-K-M's NEW *Pressure Sealing* GATE VALVE

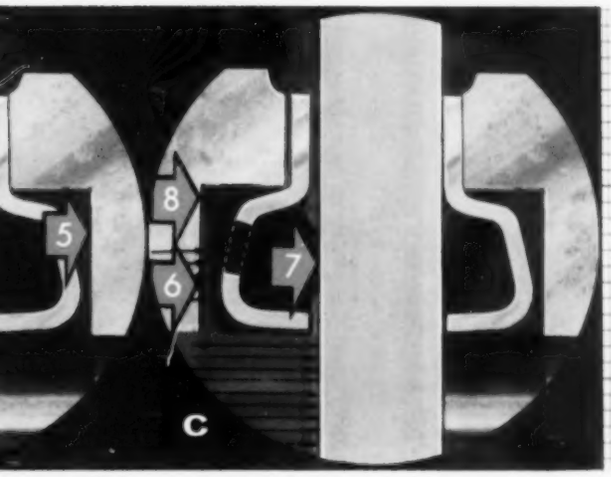
Two-

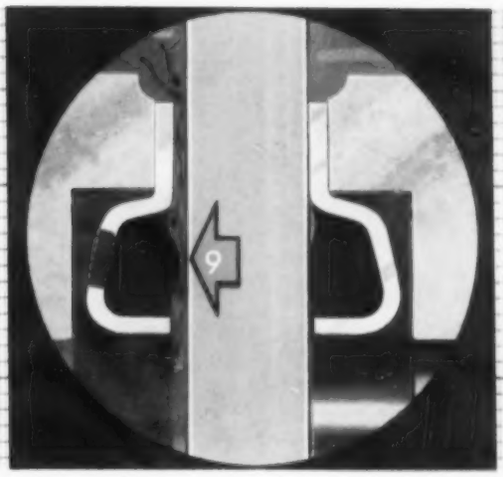
W-K-M's Pressure way valve. It may be either side. This valv block and bleed servi upstream and downs of pressure with the fully closed position.

Full Bore,

The full bore, t tion provides a perfe valve, eliminating foreign matter might smooth flow with no drop than through a

Perfect Seal





the Seats!

le action provides a bubble-tight
m seal.
ostream seal shown in Illustration
d by line pressure forcing its way
seat recess behind the upstream
thereby moving the seat against
7). This pressure is sufficient to
positive seal between the gate and
f tough rubber on the face of the
ie same time, the raised rim of soft
the back of the seat forms a tight
the seat recess (8).
double-action floating seats pro-
positive seals—both upstream and
m.

Two-Way Valve

Pressure Sealing Gate Valve is a two-
It may be installed with the pressure on
This valve is especially well suited for
bleed service since it seals positively both
nd downstream. The body may be bled
with the gate in either the fully open or
l position.

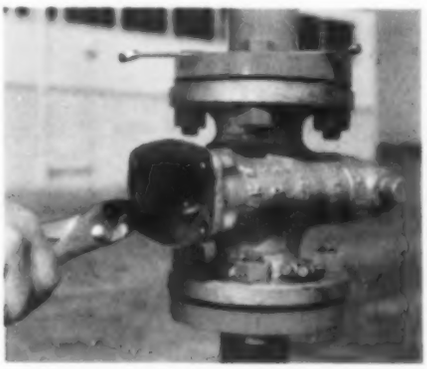
l Bore, Through-conduit

ull bore, through-conduit gate construc-
les a perfectly smooth bore through the
minating pockets or cavities in which
tter might accumulate. Result: perfectly
w with no more turbulence or pressure
through an equal length of pipe.

IMPORTANT SAFETY FEATURE:

Automatic Relief of Excessive Body Pressure

This valve has been designed to automatically relieve excessive body pressure caused by thermal expansion. The excess pressure forces the upstream seat away from the gate (9), allowing it to bleed into the line.



Change Seats in Minutes

...on the Line!

Construction of the valve is so strong and materials are so durable that users so far have found maintenance unnecessary. But in time every material wears, and some maintenance is required.

When that time comes you can change the seats in W-K-M's Pressure Sealing Gate Valve (2″ through 12″) in 15 to 30 minutes *on the line*. The only tools needed are a wrench to loosen the body bolts, and a pair of pliers.

BOLD ADVANCE
IN VALVE DESIGN

ON
MOST VE
EVE

This superior valve gives you all these advantages:

- Tight seal both up and downstream in open and closed position
- Full bore, through-conduit
- Non-lubricated
- Seats automatically adjust for wear
- Automatic relief of excessive body pressure
- Ideal for abrasive ladings, light gases, volatile liquids up to 250° F.
- Easy to overhaul on the line

Natural Gas Transmission

Crud

Prove

This new valv
pressures up to
250° F. Here are
will perform effic

Gasoline
Abrasive Slurries
Alkaline Solutions
Solvents
Nitric Acid

SP

Valve Size	2"		
ASA Rating (lbs.)	150	300	15
Screw End	X	X	X
Weld End	X	X	X
Weld by Flange	X	X	X
Flanged End	X	X	X
Gear Operated			

AVAILABLE

For complete information

WRITE

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'S *Creative Engineering*

5901

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Crude Oil

Butane/Propane

Natural Gas Distribution

roved in the Field!

new valve is extremely versatile. It's designed for up to 720 psi (cwp) and temperatures up to Here are only a few of the services in which it orm efficiently and economically.

- Sulphuric Acid
- Methyl, Ethyl, Butyl, Propyl Alcohols
- Ethylene Glycol
- Butyl Stearate
- Kerosene
- Naphtha
- Stoddard's Solvent
- Carbon Tetrachloride
- Water
- Air

SPECIFICATIONS

2"		3"		4"		6"		8"		10"		12" *	
	300	150	300	150	300	150	300	150	300	150	300	150	300
	X	X											
	X	X	X	X	X	X	X	X	X	X	X	X	X
	X	X	X	X	X	X	X	X	X	X	X	X	X
	X	X	X	X	X	X	X	X	X	X	X	X	X
						X	X	X	X	X	X	X	X

*14" and larger available on request

BLE NOW at competitive prices from your supplier.

formation about W-K-M's new Pressure Sealing Gate Valve . . .

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ON THE LINE

Common Curriculum in Engineering

Speaking before the Middle Eastern district of the A'EE, Joseph C. Michalowicz, head of Electrical Engineering Department of Catholic University of America, urged attendents to give serious attention to the establishment of "one common, four-year undergraduate curriculum in engineering."

Establishment of a common engineering program would encourage the pooling of engineering talents and facilities on our campuses, and "would lead to a great unifying force in engineering education." Michalowicz outlined a common curriculum for various engineers consisting of a three-year 'core' program and a full-year of electives.

Adopting this plan, a student may choose one of three paths in reaching his academic goal. He may take specialized courses in his senior year and receive a bachelor's degree in that field; he may continue to take courses of the 'core' variety for a degree in general engineering-science; or he may plan a senior year program with a master's degree, or a Doctorate, as his objective.

Stork, Stock and Statehood

Stork, stock, statehood and a century of business all combined to celebrate Gardner-Denver Company's centennial May 15.

The stork—first baby born on May 15 in Honolulu, Hawaii, and Anchorage, Alaska, our latest members of United States, received five shares of stock in the Gardner-Denver Company.

The shares are worth about $50 each presently.

Winners of the "Baby Sweepstakes" contest are Kent Kenji Maragame of Lihue, Kauai, Hawaii, and Philip Bruce Block of Anchorage, Alaska.

Electronic Controls and Power

Chief topic for the American Institute Electrical Engineers at their sixth electrical conference will be reduction of costs in the petroleum industry. At the conference, to be held at the Wilton Hotel, Long Beach, Calif., August 23-26, a number of papers will be presented on such subjects as the future place of computers in pipe line control and the application of automatically controlled large synchronous motors to gas transmission systems.

Approximately 700 engineers are scheduled to attend the meeting. To broaden the knowledge of specialized electrical petroleum engineers, the transportation and refining field trips will be combined this year and will include stops at pipe line, control center, refinery, unloading, and compressor station facilities.

So You Want to Learn Chemistry!

A nation-wide advanced chemistry for credit television program is scheduled to start September 26 over NBC at 6:30 to 7 A.M. five days a week.

Purpose of the program, "Modern Chemistry," primarily is to expand secondary school science teachers knowledge of chemistry and improve teaching methods. Also it will acquaint the general public with chemistry and the chemist. The chemistry professor will be John F. Baxter of the University of Florida.

Emphasis of the course will be on structure, particularly the relationship of structure to the chemical and physical properties of substances. Guest lecturers will assist Baxter from time to time. The 160 lessons will be interrupted by the usual vacation periods.

In connection with the chemistry course, NBC will telecast its Atomic Age Physics program which was originally run in 1958. The physics class starts at 6 A.M.

Pipe Line Construction Scenes

Depicting typical construction work in various climates and terrain found in the United States and Canada, comes in a highly illustrated publication by Western Pipe Line, Inc.

Reviewing work of 1958 on Trans-Canada, Tennessee Gas Pipeline Company, El Paso Natural Gas, Texas Eastern Transmission Corp. and Southern Natural Gas Co., the illustrations point out the obstacles and accomplishments of contractors and pipe line companies in completing a major project.

Petroleum Library

The National Petroleum Bibliography library has been opened in Amarillo, Texas. The library, with over 5,000 publications dealing with every aspect of the petroleum industry, will be available to local industry in the Texas Panhandle areas for reference and research purposes.

Oakite ECP...

Do your pipelines suffer from hardening of the arteries?

Pipelines lined with scale and sludge act just like hardened arteries – impeding circulation, increasing the necessary pumping effort.

With pipelines, fortunately, there's a quick remedy. Full efficiency can be restored through cleaning by chemical circulation, using Oakite methods and materials ... getting the benefit of Oakite ECP.

What's ECP? It's an Engineered Cleaning Program that takes into account your own individual soil problems, your requirements, your equipment. The Oakite Engineer lends personal and experienced supervision to the program, insures that the job is done at lowest possible cost.

Call your local Oakite man now. There's no obligation, of course. Meanwhile, for more information, write to Oakite Products, Inc., 51A Rector St., New York 6, N.Y.

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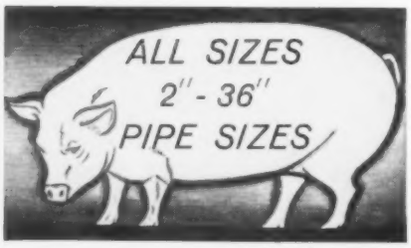
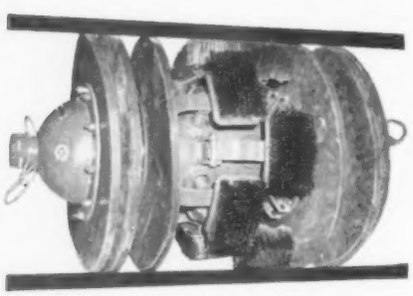
MYOCO PIPELINE PIGS



ANY COMBINATION ALWAYS IN STOCK



MYOCO S-18 COLLAPSIBLE PIG

Especially designed for use on dual diameter lines and lines with small I. D. full opening valves within collapsible range. Sturdily built of lightweight aluminum castings with spring loaded brushes and collapsible rubber discs, the S-18 assures maximum cleaning action.

COLLAPSIBLE SIZES: 36" to 30", 30" to 24", 24" to 20" and 20" to 18".

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What's Happening among SERVICE and SUPPLY MEN

PEPA Elects Officers for 1959-60

The Petroleum Electric Power Association elected officers for 1959-60 at its 31st annual meeting in Galveston, Texas, last month. Officers (left to right) are W. M. Larkin, Gulf States Utility Company, Lake Charles, La., vice president; D. S. Coffman, Texas Power & Light Company, Dallas, president; and B. F. Thompson, Public Service Company of Oklahoma, Tulsa, secretary-treasurer. Other directors include Langston Ashford, Central Power & Light Company, Corpus Christi, Texas; Paul Atwell, Mississippi Power & Light Company, Jackson, Miss.; Jas. E. Moody, Southwestern Electric Power Company, Dallas; Harold S. Nay, Kansas Gas & Electric Company, Wichita, Kans.; J. L. Satterfield, Pacific Power & Light Company, Wyoming Division, Casper, Wyo.; John Odom, Texas Electric Service Company, Midland, Texas; Paul B. Farris, The Empire District Electric Company, Joplin, Mo.; Kirby Dawkins, West Texas Utilities Company, McCamey, Texas; Roger K. Owen, Southwestern Public Service Company, Amarillo, Texas.

Walter F. Munford Elected United States Steel President

Walter F. Munford was elected president and chief administrative officer of United States Steel Corporation. Munford succeeds Clifford F. Hood who retired after 40 years in the steel industry. Hood will continue to serve as a member of the board of directors and executive committee of the corporation.

Munford also was elected a director and chairman of the executive committee. He had been executive vice president, engineering and research. Prior to that he had been assistant executive vice president for two years and, from 1953-1956, he was president of U.S. Steel's American Steel and Wire Division. Munford began his career with the corporation in 1923.

Stephen M. Jenks succeeds Munford as executive vice president, engineering and research. Jenks has been associated with the corporation since 1925. He became assistant vice president, operations, in 1953 and in 1958, became administrative vice president, central operations.

Allis-Chalmers Manufacturing Co. Announces Several Appointments

Allis-Chalmers Manufacturing Company has announced several personnel appointments. J. E. Despins has been named manager, Mexico district for Allis-Chalmers de Mexico, S.A., de C. V. succeeding R. B. Rodriguez, who has retired.

John L. Wiedey has been appointed marketing manager, Pittsburgh Works, and George W. Hanafee is now manager of the Indianapolis district. Joseph J. Jacobs has been appointed assistant chief engineer of the West Allis Pump Department of the General Products Division.

Despins has been with the company since 1936 and had been manager of the El Paso, Texas, office since 1949. Wiedey had been manager of the Indianapolis district since 1957 and has been with Allis-Chalmers since 1946. Hanafee became a sales representative in the Indianapolis district in 1952. Jacobs started as design engineer in the Pump Department in 1940 and was engineer in charge of design before receiving his promotion.

Dresser Industries Appoints Brown Director of Manufacturing

John R. Brown, Jr., has been named director of manufacturing for Dresser Industries, Inc. He had been with Baldwin Lima Hamilton Corporation in Eddystone, Pa., since 1941. At Baldwin Lima Hamilton Corporation, Brown was successively coordinator of industrial engineering, general superintendent for transportation products, manager of foundries, and works manager.

J. R. Brown, Jr.

He will be a member of the headquarters staff and be responsible for evaluating manufacturing processes and procedures, analyzing the capital expenditures program and making recommendations in general business areas.

Cooper-Bessemer Announces Election Of Charles G. Cooper as Vice Pres.

Charles G. Cooper has been elected vice president and international director of the Cooper-Bessemer Corporation. Several other Cooper-Bessemer appointments include Leopold A. Ffrench, named to the international office; Harry A. Cecsarini, European manager of Cooper-Bessemer, S.A.; and Earl Martin, Houston branch manager.

C. G. Cooper

Cooper also is a director of Cooper-Bessemer International Corporation, Cooper-Bessemer of Canada, Ltd., and Cooper-Bessemer, S.A. Ffrench will work directly under Cooper and will devote his attention to the application and sales of engine-driven and motor-driven compressors for overseas installation.

Cecsarini has spent 10 years in manufacturing, engineering and sales with Cooper-Bessemer. Martin will be in direct charge of both application and sale of Cooper-Bessemer compressors and engines in the Houston area.

Tex-Tube, Inc. Announces Office Expansion Program

Tex-Tube, Inc., announces an expansion program which will add to both office and plant space. With the addition of a two-story L-shaped unit, Tex-Tube will double its office space which now covers 6,000 square feet. Present office consists of a single-story L-shaped building. New equipment will be added to the plant and a 50 by 200-foot building for storage of machinery will be constructed. Additional storage yard and railroad tracks will be included.

Worthington Corporation Appoints Fred O. Snyder District Manager

Fred O. Snyder has been named manager of Worthington Corporation's district sales office in Cincinnati. He succeeds Ralph G. Griffin who has been transferred to the company's Harrison, N. J. office.

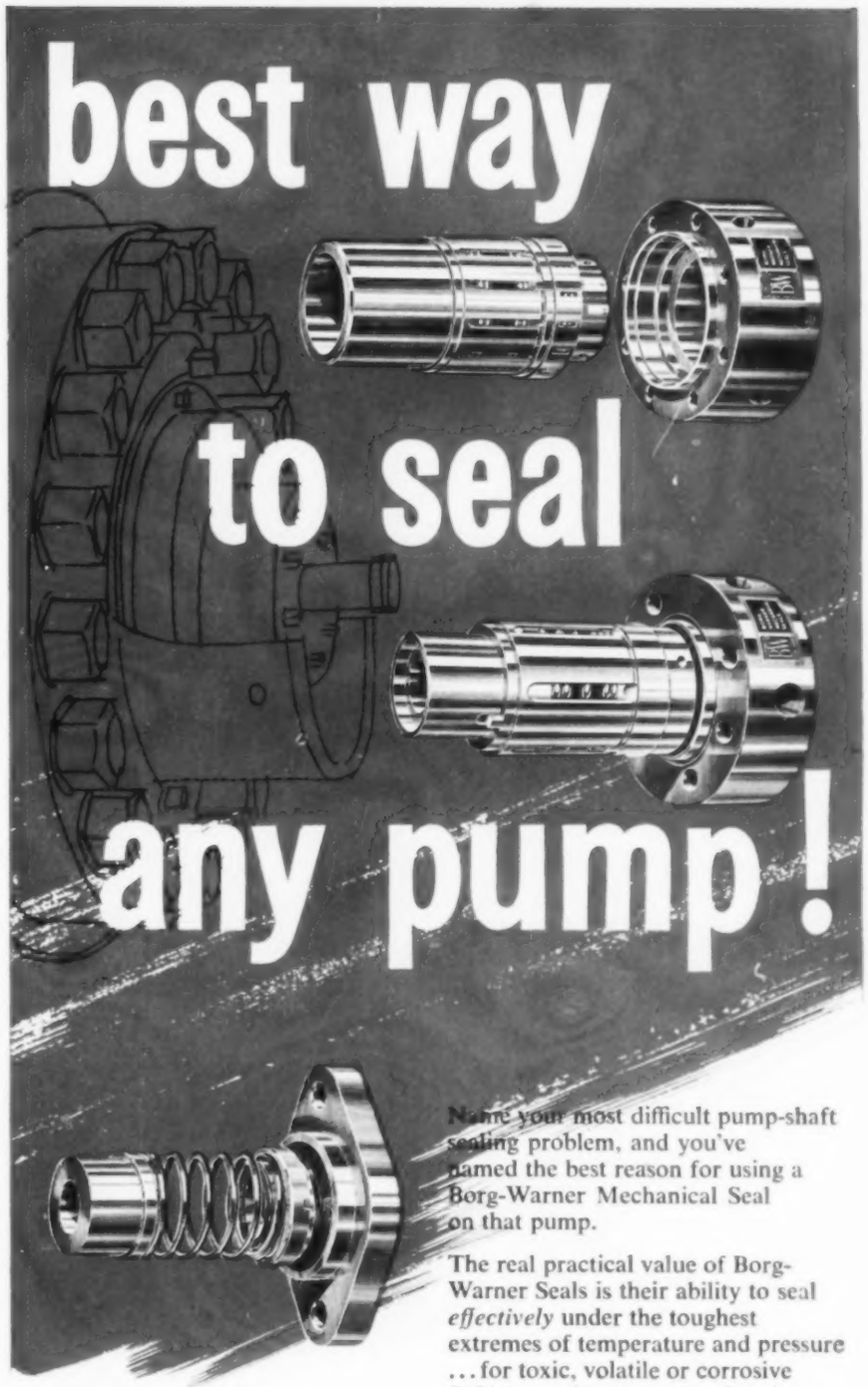
F. O. Snyder

Snyder joined Worthington in 1941. Prior to his promotion he served as a sales representative in the Cleveland area.

John T. Brown Re-elected J. I. Case Board Chairman

John T. Brown has been re-elected chairman of the board and Marc B. Rojtman president for J. I. Case Company.

Newly elected vice presidents of the firm are D. A. Beckenbaugh, sales and manufacturing administrator; Jack L. Bush, controller; Gordon A. McMillan, director of Canadian operations; David A. Milligan, head of the industrial division; and Frank J. Palermo, in charge of manufacturing operations of the company.



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The real practical value of Borg-Warner Seals is their ability to seal *effectively* under the toughest extremes of temperature and pressure ... for toxic, volatile or corrosive fluids ... and even some abrasive liquids. *Result* – less down time, elimination of expensive stuffingbox maintenance, and savings of the pumped fluid.

Borg-Warner Mechanical Seals

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Borg-Warner® Mechanical Seals

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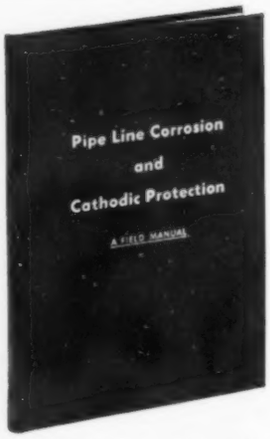
For more data on advertised products, use Readers' Service Cards, last page.

Frank Wheatley Pump and Valve Announces Several Staff Changes

Frank Wheatley Pump and Valve Manufacturer announces a change in name of a subsidiary and several promotions in its firms. Frank Wheatley Supply has changed its name to Frank Wheatley Corporation.

A. R. Parker, formerly of Mission Manufacturing, Mud Products Company, and Baroid Corporation, will serve the Mid-Continent and Gulf Coast area for Frank Wheatley Corp. Gus Baker, Jr., has been named to the post of executive vice president of Frank Wheatley Pump and Valve. Huber Dye, vice president and general manager of the Frank Wheatley Corp., is now vice president of Frank Wheatley Valve and Pump. William Gray becomes special advisor to the manager for the company.



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Pipe Line Corrosion and Cathodic Protection

By MARSHALL E. PARKER

This book is designed as a practical field manual. It provides workable methods that can save you valuable time and effort in obtaining interpretive field data.

Contents (Condensed). Soil Resistivity Surveys, Pipe-to-Soil Potentials, Line Currents, Current Requirement Surveys, Rectifier System for Coated Lines, Ground Bed Design and Installation, Magnesium Anodes on Coated Lines, Hot Spot Detection, Stray Current Electrolysis, Interference in Cathodic Protection, Operation and Maintenance, Coating Inspection and Testing.

Appendices cover: Fundamentals of Underground Corrosion, Basic Principles of Cathodic Protection. Plus . . . tables and properties of metals, attenuation equations and index.

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THE GOODMAN CYLINDRICAL STOPPER

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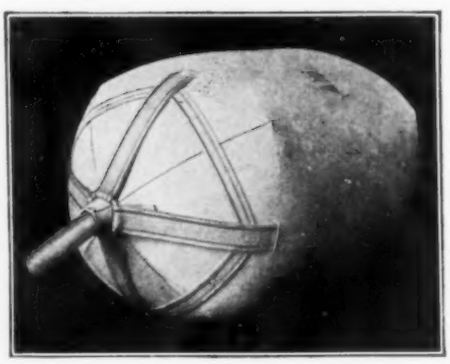

The Goodman Cylindrical Stopper is an inflatable bag with a rugged water-proofed casing which may be inflated to a high internal pressure and will hold against as much as ten pounds pressure in the pipe.

The broad central zone makes contact with the wall of the pipe and holds against a higher pressure than other types of bag.

This Stopper has been used successfully for testing soil pipes in new buildings and for stopping oil pipes around refineries. Water-works engineers use it to save pumping while altering or repairing mains where leaky valves are encountered. It is now giving satisfaction in sewer work, and in at least one instance it saved a city water-works a large expenditure of money.

Safety Gas Main Stopper Co., Inc.

523 ATLANTIC AVENUE
BROOKLYN 17, N. Y.

J. Y. Allen, Jr.

E. G. Hotze

Clark Bros. Co. Announces Appointment of Three Managers

Clark Bros. Co. announces the appointment of three district managers. Ernest G. Hotze has been made southwest district manager; Joe Y. Allen, Jr., is the new Houston district manager; and James R. Hutton becomes manager of newly created Louisiana-Mississippi district. Hotze will be responsible for the sale of Clark engines, compressors and gas turbines throughout Texas (except the Panhandle area), Mississippi, Louisiana, Southern Arkansas and Southern New Mexico. Allen will be in charge of the Clark-Houston and Corpus Christi offices serving the Texas Gulf Coast. Hutton's district includes Southern Arkansas, Louisiana and Mississippi.

J. R. Hutton

Four New Sales Positions Established by Crane Company

The establishment of four new major sales positions has been announced by the Crane Co. Darrell R. Nordwall has been appointed general manager of branch sales; Charles H. Lovelace, general manager of engineering sales; R. W. Lindsay, general manager of wholesaler sales and Clarence E. Watson, general manager of atomic energy sales.

Nordwall, a 27-year veteran of Crane, was promoted to the company's general office in 1958. Lovelace, who joined Crane in 1938, has been in charge of its industrial sales and merchandising for three years. Watson has been associated with Crane's government sponsored research and development work since last December.

Canadian Companies Plan Steel Pipe Mill in Edmonton

Page-Hersey Tubes, Limited, and The Steel Company of Canada, Limited, plan a joint venture to build a steel pipe mill in Edmonton, Alta., Canada, to produce line pipe from 16 to 42 inches in diameter.

The new mill will be established as a separate company. Cost is not to exceed $10 million.

Grove Valve and Regulator Co. Names Williamson Asst. Sales Mgr.

Kenneth F. Williamson has been named assistant sales manager of Grove Valve and Regulator Company. Williamson, who had been with W-K-M as sales coordinator, will be headquartered in Grove's Oakland, Calif., office.

R. H. Welker Joins Accessory Products Co.

R. H. Welker has joined the Accessory Products Company, division of Textron Inc., as sales engineer. Welker recently developed a pressure reducing regulator and had formed his own company, Welker Engineering Company. APCO has completed an agreement to manufacture and sell this regulator.

R. H. Welker

Prior to forming his own company, Welker had worked with Tennessee Gas Transmission Company for 8 years, as measurement engineer. At APCO, he will handle manufacturing, sales organization and engineering of the regulators. Presently they are made in 1-inch and 2-inch sizes; they will be made in larger sizes.

DeFiore Named Engineering Director For Youngstown Sheet and Tube Co.

Leo DeFiore has been named director of engineering and Carl J. Lucas chief engineer, for Youngstown Sheet and Tube Company. DeFiore has been chief engineer since 1956. He joined the company in 1917 as a draftsman in the Engineering Department. Lucas came to Youngstown in 1946, became district engineer in 1954, assistant to chief engineer in 1956 and in 1957 was appointed assistant chief engineer in charge of projects and development.

Bowman Elected Vice President Of Rockwell Manufacturing Company

Gilbert T. Bowman, assistant vice president of Rockwell Manufacturing Company's meter and valve division, has been elected a vice president of the company. He will be in charge of the international division and petroleum and industrial division. Bowman joined Rockwell in 1940 as sales engineer, became San Francisco district sales manager in 1945, sales manager-gas products and Nordstrom valves in 1952, and general products manager in 1954. He was promoted to his most recent position in 1956.

G. T. Bowman

Jones & Laughlin Completes New Building in Colorado

Jones & Laughlin Supply Division announce completion of its new store building at Rangely, Colo. The building will be used as a supply store to serve customers in the northwestern Colorado area. The Rangely store is under Jones & Laughlin's Central Rocky Mountain area at Casper, Wyo. W. T. Fleming is store manager and T. G. Row is salesman.

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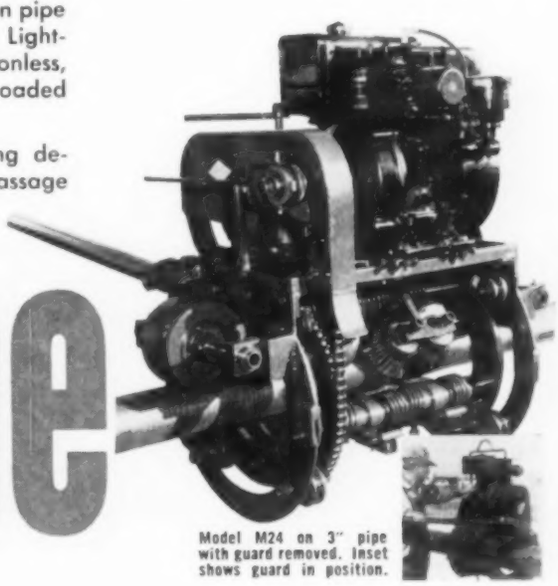
cleans pipe faster

NEW REMCO SELF PROPELLED PIPE CLEANING MACHINE MOUNTS IN 15 MINUTES!

Perfect for new pipe or reconditioning work, this new, compact cleaning machine will clean pipe up to 10 times faster. Lightweight and nearly vibrationless, it is ideal for working on loaded lines.

With an exclusive floating design which permits easy passage over collars, it uses standard knives, cutters and brushes or the new Remco rotary cup brushes. Easily adapted for taping, priming, doping, or for stationary service, it comes in 6 standard sizes for 2" through 30" pipe.



Model M24 on 3" pipe with guard removed. Inset shows guard in position.

OTHER REMCO PIPELINE EQUIPMENT INCLUDES:

HOLIDAY DETECTORS—CLEANING AND PRIMING MACHINES—TAPE WRAPPING MACHINES—DOPE KETTLES — PIPE FINDERS SUPPLIES

REMCO

MANUFACTURERS AND DISTRIBUTORS OF PIPELINE EQUIPMENT AND SUPPLIES

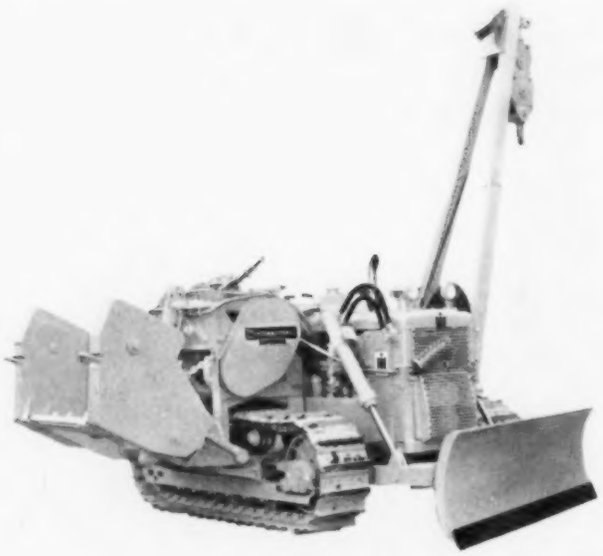
REMCO MFG. CO.

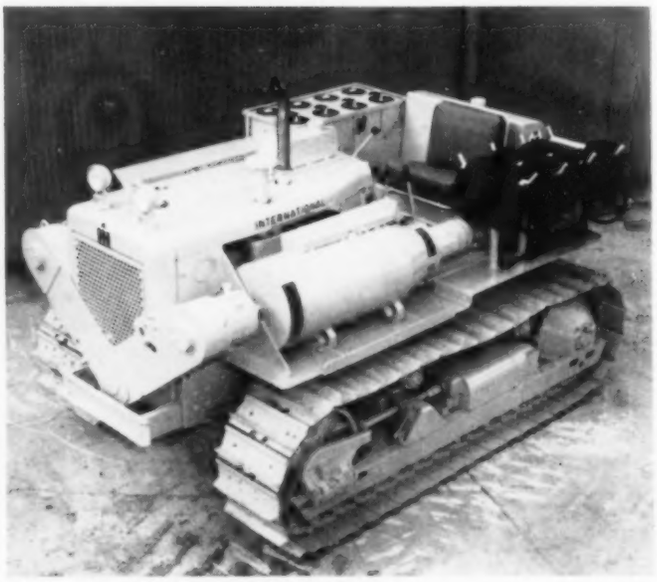
BOX 3005 • TULSA, OKLAHOMA

PHONE: TEmple 5-1504

What's New in EQUIPMENT

To receive more information on all new equipment articles use Readers' Service Card, last page of this issue.





IH Announces New Sidebooms and Welding Unit

Two new International Superior sidebooms, a welding unit and slush pit tractor, have been introduced by International Harvester Company.

The largest is the SBI-150-BH sideboom, a hydraulic counterweight machine capable of lifting 46,500 pounds of pipe at 4 feet. The 105-horsepower rig gives six-roller, rigid-track traction, with 98⅜ inches of track-on-ground length. Engine and transmission guards are completely enclosed and levers are stacked for operating ease and safety. A single drum on each shaft provides wear-saving cable alignment. Gear-driven drums assure quiet operation and exceptional longevity.

The smaller SBI-150 sideboom can pick up 34,580 pounds at 4 feet, but with back-filler blade attachment its capacity is raised to 36,310 pounds. Individual gear-driven drum shafts result in long wear life and subdue operating noises. It also has the 105-hp engine.

The tractor-powered-and-mounted welding unit is International's 150-W welder. Especially applicable for cross-country tack welds and hot pass welding, the TD crawler's 128 engine intermittent hp makes this a 325 ampere unit consisting of two welders and four leads. Control panels are located within easy reach at the operator's right, and dirt and moisture are sealed out. The unit accommodates maximum-width track shoes for maximum flotation in swampy terrain and right of way. Standard V-belt or optional chain drive transmit front power take-off.

The new TD-15 crawler tractor and Model 15DN-2 dozer feature a 62-inch gage. Over-all length of the tractor is 96 inches. The dozer has a heavy-duty, 39-inch blade with revised contour for improved digging and rolling of heaped capacity loads. As on other International dozers, tilt up to 12 inches is accomplished. New floating trunnion balls allow use of push arms with integral, rigid diagonal struts, eliminating blade side-sway.

A back-ripper attachment, consisting of two teeth mounted in housings behind the blade, loosen earth during reverse operation of tractor for faster digging on each forward pass. The TD-15 has a six-speed, full-reverse transmission, with fast shuttle-bar direction changing. It has a six-cylinder diesel engine and 1,000-hour lubrication-interval, heavy-duty track rollers.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.

Spherical-Type Valves

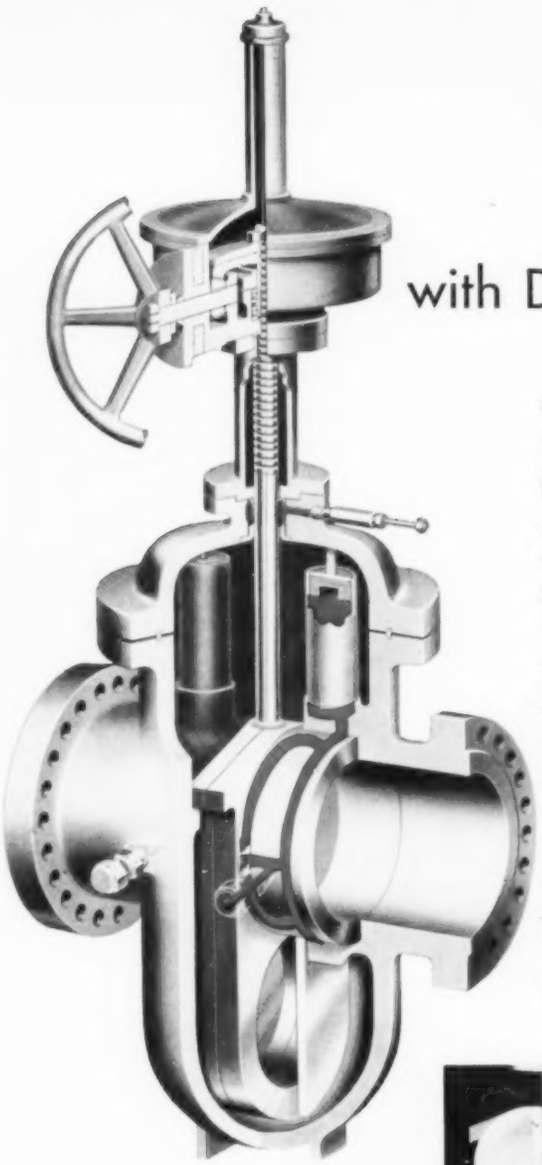
Rockwell Manufacturing Company announces its full-opening, spherical-type valves for gas, oil and products pipe lines. The valves are constructed of carbon steel and have only four main parts, the operating stem, ball plug, two spherical ring seats and the body housing. Only the operating stem and ball plug are moving parts.

The valves are available in sizes 16, 20, 24 and 30 inches and in such combinations as 36 by 30 by 36 inches. Pressure ratings are ASA 400 pounds, 1000 pounds WOG, 1250 pounds WOG and ASA 600 pounds. For 20-inch and larger, hypresphere valves are standard with 4-cylinder hydraulic operators for manual or line pressure operation.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

NEW ADVANTAGES "GO ON THE LINE"

with DARLING-McEVOY Conduit Valves



Above: *Cutaway showing heavy, self-aligning gate and parallel seat assembly, with one of the two sealing systems indicated.*

Compare these features with *any* other pipe line gate valve:

1. **EVERY CLOSURE LEAK-PROOF.** No forcing. Positive automatic self-sealing under line pressure between seats and gate and between seats and body by means of sealing compound.

2. **NON-DIRECTIONAL.** Flow may be in either direction. Sealant cylinders operate independently.

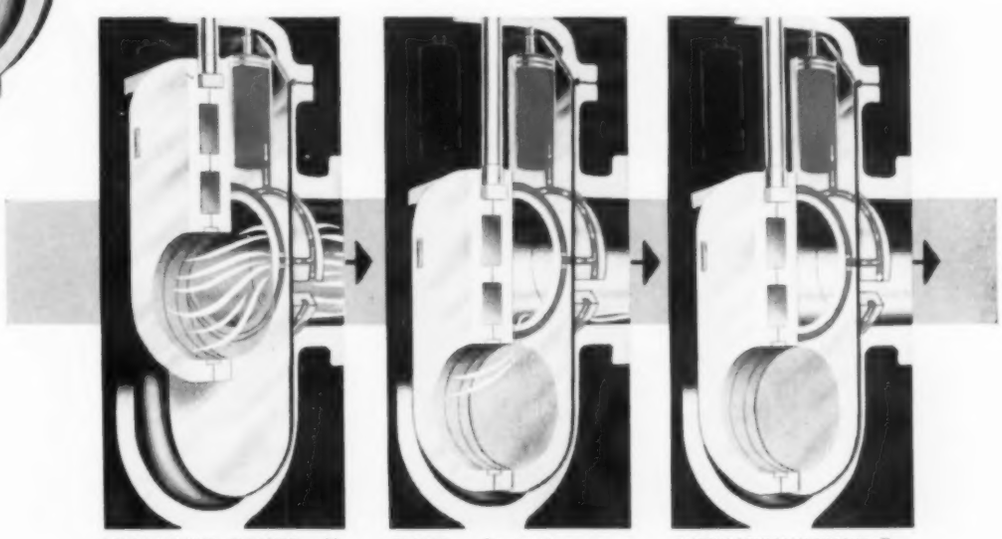
3. **TWIN SEALANT RESERVOIRS.** One for each port. Sealant feeds automatically to downstream side only.

4. **NEGLIGIBLE SERVICING.** Leak-proof closure requires very little sealant. Reservoir capacity ample for 50 to 80 operations dependent on differential pressures.

5. **SMOOTH, FULL FLOW.** No impediments. No turbulence. No pockets to collect sediment.

6. **EXCEPTIONAL PERFORMANCE AND LIFE.** Self-aligning gates. No wedging. Non-distorting seats, protected when valve is open or closed.

Darling-McEvoy conduit valves, made in 4" and larger sizes, are fully field proved and are now operating continuously on various major lines. For complete information on the self-sealing feature and many other advantages of this unique valve, ask for Bulletin 5402.



Right: *Diagrams of closure action on downstream side of gate.*

APPROACHING CLOSURE... *No loss of sealant as sealing groove in seat is disconnected from reservoir until gate is fully closed.*

CLOSED... *Jumper in gate now permits differential pressure to feed sealant into seat groove to check any remaining flow.*

AUTOMATICALLY SEALED. *Pressures again in balance. Tightness established. No additional sealant used until again needed.*

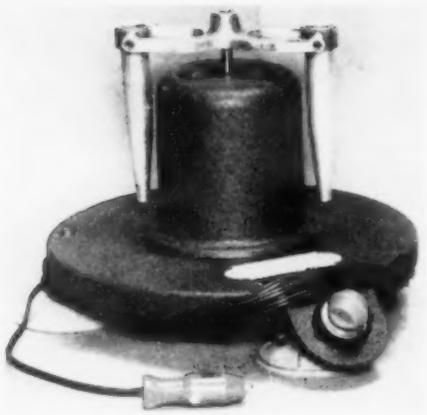
DARLING VALVES

DARLING VALVE & MANUFACTURING COMPANY

Williamsport 27, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

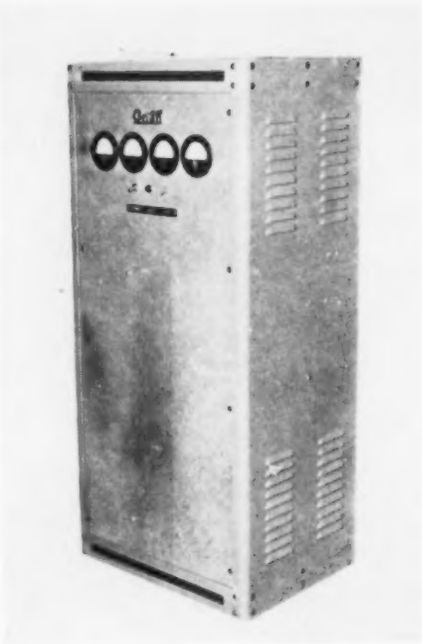


Portable Electric Centrifuge

A lightweight, compact portable electric centrifuge and new heated centrifuge have been introduced by W. L. Walker Company. With a long cord and adapter, the electric model can be plugged into a vehicle cigarette lighter socket and then placed in a location where there is room for spinner head to revolve. It is equipped with three-speed switch with pilot light for convenience.

The new 100 ml MARK 11 heated centrifuge includes pear shaped tubes in its new mechanism. It provides facilities to preheat samples and keep them hot during the spinning period. This affords more consistent testing conditions, regardless of weather, assuring higher degree of consistency and accuracy in bs&w measurement tests.

For more data, circle **No. E3** on Readers' Service Card, last page this issue.



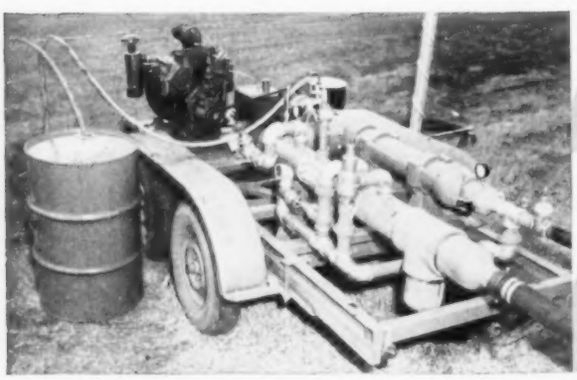
Inverter Power Unit

An inverter power unit has been developed by D. W. Onan & Sons, Inc., for use in conjunction with standby equipment in microwave installations. The inverter power unit will supply adaquate AC power to operate vitally essential radio equipment in microwave stations for the interval required to automatically start the standby plant.

Onan engineers claim the new unit will take any power load up to 5KVA within 8 to 28 milliseconds, depending on what part of the AC line cycle that the interruption occurs. A 1KVA model is in production with units up to 5KVA and is expected shortly. The power unit is a transistorized inverter operating from a 36-volt storage battery system. It provides 1KVA of standard 115-volt, 60-cycle current.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

WISCONSIN-POWERED
Portable Tank Cleaner



DOES DOUBLE DUTY...

This unique pumping unit, made by the Para-Lax Corporation, Sand Springs, Oklahoma, comprises a Robbins & Myers Moyno pump and a Wisconsin Model VH4D 4-cylinder, V-type heavy-duty air-cooled engine. It performs a valuable double service: (1) Cleans large storage tanks while still on stream; (2) through the application of a new method (utilizing Para-Lax paraffin solvent), recovers all of the good oil from bottom settlings.

In this process, varying quantities of the solvent are pumped to the bottom of the tank where it starts to dissolve the paraffin. This solvent is pumped through a large, ingeniously designed *rake* that provides contact over a large tank area. The viscous "bottoms" become pumpable and the "cut" fluid is circulated and heated if necessary, to recover all of the good oil. The capacity of the unit on this application is about 200 BPH at 150 lb. pressure (needed to give proper agitation on the jet-action rake).

The Model VH4D Wisconsin Air-Cooled Engine is equipped with Stellite exhaust valves and valve-seat inserts, positive-type valve rotators, side-mount fuel tank, clutch, and explosion-proof muffler and ignition. The entire unit is designed for efficient operation with maximum protection against shutdowns.

For all-weather operation of your oil field utility units, self-sustaining dependability, long life and low-cost maintenance, *you* can't do better than to specify "Wisconsin" power for *your* equipment.

WISCONSIN MOTOR CORPORATION
Milwaukee 46, Wisconsin

WRITE TO HARLEY SALES CO.
619 SOUTH MAIN STREET • TULSA, OKLAHOMA
3420 McKINNEY AVENUE • HOUSTON, TEXAS
505 SOUTH MAIN STREET • WICHITA, KANSAS
Oil Field Distributors for Wisconsin Engines and all types of Utility Engines

World's Largest Builders of Heavy-Duty Air-Cooled Engines

Collapsible Building

A mobile and collapsible building that can be erected in 20 minutes and ready for occupancy as a pipe line office on the spread has been introduced by Porta-Kamp Company, Inc.

The rugged, strong building can be taken down into a very small package making it easy to handle and cheap to transport. Steel skid-mounted to stand any weather or field use, there are no nails to hammer in construction. Lock bolts are used on corner supports.

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

Clean PIPELINES
Reclaim TANK BOTTOMS
with **BrakeSol**®
an exclusive
PARAFFIN TREATING CHEMICAL

BRAKESOL holds paraffin in suspension! Inject it into gathering lines and BRAKESOL keeps them free of paraffin.

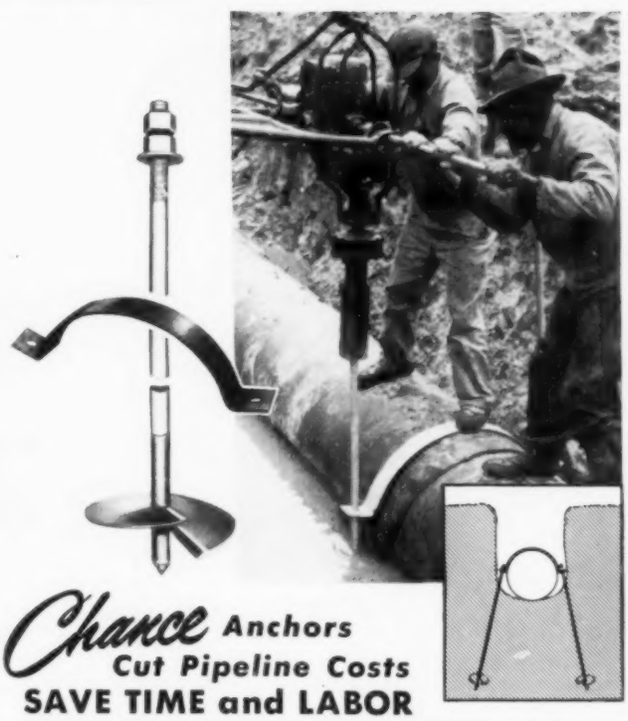
BRAKESOL reclaims tank bottoms without taking tanks out of service! BRAKESOL chemically dissolves paraffin and puts it back in solution into the oil. Cost is nominal compared to savings.

BRAKESOL is safe to handle and will not harm your equipment. Let BRAKESOL eliminate your paraffin problems NOW!

FOR SERVICE . . . Contact your Supply Store or nearby BrakeSol Treating Engineer.

BrakeSol INC.

P. O. BOX 9506 • OKLAHOMA CITY, OKLA.
EXPORT DISTRIBUTOR: THE NATIONAL SUPPLY CO., EXPORT DIVISION



Chance Anchors
Cut Pipeline Costs
SAVE TIME and LABOR

The modern, effective method of anchoring pipeline is with Chance Pipeline Anchors and Brackets. It is the lowest cost, easiest, surest way to keep pipe from floating. Can be installed with hand tools or light power equipment.

A·B·CHANCE CO. CENTRALIA, MISSOURI
A B CHANCE COMPANY OF CANADA, LTD., TORONTO

F.H. Maloney COMPANY

IN THE DARK...

ABOUT SCRAPER CUPS?

All Scraper Cups look pretty much alike, particularly today, since the flexible shoulder design pioneered by Maloney Scraper Cups has become standard and widely copied in Scraper Cups.

But Scraper Cups operate in the dark, where looks don't count, and performance does. It is at the end of the run, in the receiving barrel, where performance shows up.

Tough rubber compounds, outstanding physical design, and consistency in production — all are features of the Maloney Scraper Cup that insure top performance in run after run.

Write today for full descriptive literature and the name of the nearest Maloney distributor. Available immediately for fast shipment — to fill your needs. See the light—specify "Maloney."

"Something From The Irishman"

P. O. BOX 1777 • HOUSTON 1, TEXAS
CHICAGO • LOS ANGELES • PITTSBURGH • TULSA

Wheeled Tractor

FWD Corporation announces a versatile "Blue Ox" wheeled tractor equipped with a Sooner Boomer side-boom for pipe line construction work. The side-boom can lift 17,500 pounds at a 4-foot radius; the tractor is equipped with an 80 by 36-inch backfill blade mounted on the front. It can move up to 45 mph with its 132 horsepower gasoline engine located in the rear.

The tractor is designed for a drill to be mounted on rear. A low-pressure type air compressor driven from the tractor's transmission power takeoff furnishes power for the drill.

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

Enclosed Time Switches

General Electric's standard outdoor time switches are now supplied in an underwriters' laboratories approved rain-tight case, the company recently announced.

The rain-tight listing covers the regular service TSA-41 time switch and the heavy duty TSA-40 model. Both time switches feature a 24-hour dial, which on the 41 can be set for 12 on-off operations per day, or on the 40 for 16 on-off operations every 24 hours. An omitting device is offered for skipping a day or more of operation. Other features include dead-front construction, easily accessible terminals, numerous "knockouts" in the case, a removable cover and a precision electric-clock motor.

(This item supplements General Electric data on pages 199-202 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E7** on Readers' Service Card, last page this issue.

Air-Operated Impactool

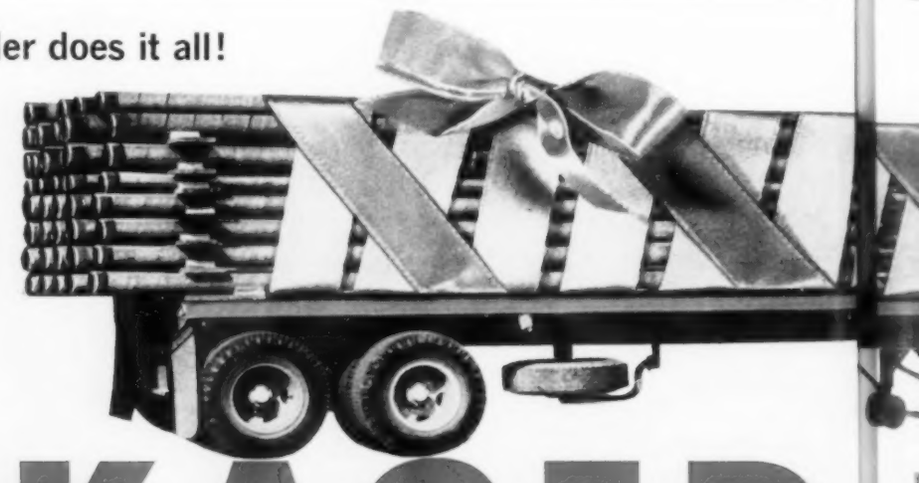
Ingersoll-Rand announces an air-operated Impactool with a 1-inch drive and featuring a direct drive between motor and hammer.

Main application of the tool is for heavy truck wheel work and spring-U-bolt jobs. The machine also includes a built-in, calibrated power regulator, with four positions to permit the operator to cut the power as much as 40 percent.

(This item supplements Ingersoll-Rand data on pages 241-248 of the Pipe Line Catalog, Second Edition.)

For more data, circle **No. E8** on Readers' Service Card, last page this issue.

Lower costs! One purchase order does it all!



PACKAGED

NOW—A REVOLUTIONARY NEW LOW-COST CONCEPT IN PIPE BUYING

Southern Pipe PACKAGED PIPELINES offer you a brand new way to save money, cut red tape, eliminate worries. One order does it all—from pipe production and processing to trenchsite delivery. You buy one complete pipeline package, delivered when you need it.

Write for LITEWALL PACKAGED PIPELINES brochure today.

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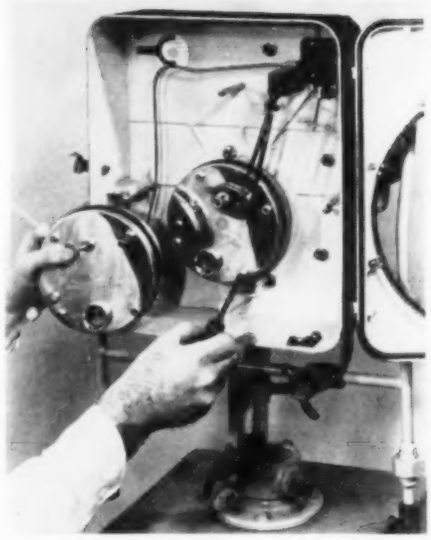


Gas-Driven Chart Drive

A completely self-contained air or gas-powered instrument drive and timing unit, Rockwell Manufacturing Company's gas-driven chart drive, is claimed to operate indefinitely and without attention as long as gas pressure is available. It provides power for the accurate and automatic operation of recording charts in many instruments including orifice meters, gas-lift intermitters, pressure recorders and temperature gages.

Particularly applicable for remote locations such as off-shore gas gathering systems, the "gas drives" feature self-starting mechanism, explosion proof units, internally sealed timing mechanism, and the unit is interchangeable with standard chart drives.

For more data, circle **No. E9** on Readers' Service Card, last page this issue.

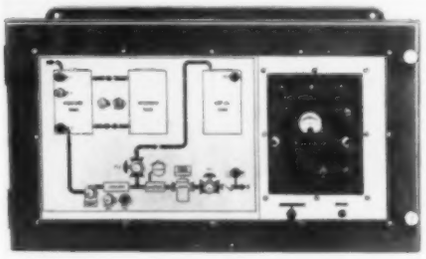
Small Valves

Crane Co. announces a 1-inch valve offering advantages of a gate valve, plug disc globe valve and resistance to corrosion.

Valve features tapered non-turning plug disc, stem pinned to disc, hand wheel attached to yoke sleeve, reduced seat and fine stem threads for accurate flow control. 'O' ring bonnet joint and a rating of 1500 psi oil, gas or water working pressure.

(This item supplements Crane Co. data on pages 121-136 of the Pipe Line Catalog, Second Edition.)

For more data, circle **No. E10** on Readers' Service Card, last page this issue.



LACT Control Panel

Instruments, Inc., announces its new model LACT-600 electric control panel designed to provide dependable and automatic delivery of oil to pipe line. One section of the panel, shown above, is a graphic illustration of the transfer system, with lights indicating liquid levels and quality, BS&W content of the crude. The section of panel, on right, is Instruments' BS&W monitor utilizing a capacitance type probe in the discharge line. The monitor provides a means of controlling excess BS&W in the oil.

(This item supplements Instruments, Inc., data on page 250 of the Pipe Line Catalog, Second Revision.)

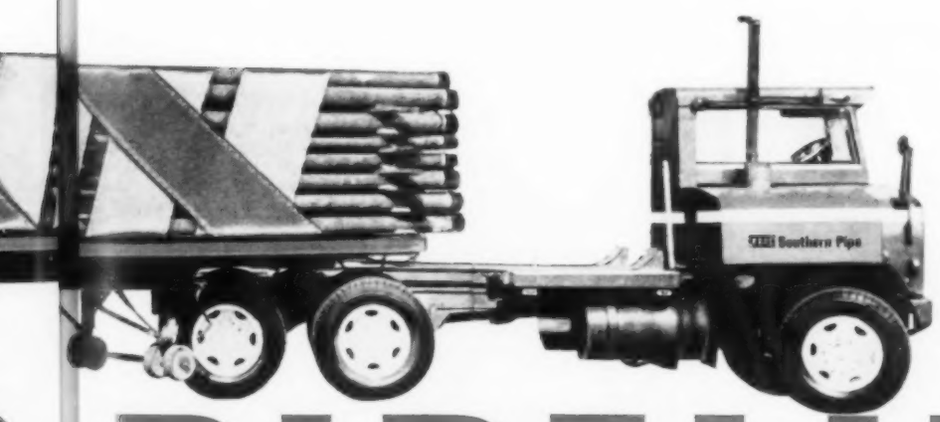
For more data, circle **No. E11** on Readers' Service Card, last page this issue.

Electronic Sensor

A new electronic unit that senses the presence of liquids or any change from liquid to gas or vice versa is announced by the Pioneer Central Division of Bendix Aviation Corporation.

The unit can be used on diversified test devices and can be installed on tanks to sense liquid levels for rate of filling or percent of capacity. It will operate in diversified fluids such as liquefied gases, hydrocarbon fuels, red fuming nitric acid, fluorides, hydrazine, water, ink and molasses and under extreme environmental conditions. The sensor, which has only one moving part, the relay armature, has a probe with a built-in transistorized amplifier and relay. The amplifier and relay can be separated from probe for specific applications.

For more data, circle **No. E12** on Readers' Service Card, last page this issue.



PIPELINES

SOUTHERN PIPE PACKAGED PIPELINES GIVE YOU: (1) pipe produced to your exacting specifications, (2) from steel coil in our own pipe mill, (3) cut precisely with NO random lengths, (4) coated (or lined) at our plant, (5) warehoused, if necessary, until you need it, and (6) delivered to your trenchsite ready for welding and placing in trench. **PACKAGED PIPELINES** come in API monogrammed pipe or in Southern Pipe's own LITEWALL pipe—a new high strength, lightweight pipe manufactured to API specifications. (Southern Pipe warehouses standard sizes for immediate delivery, too.)

USI Southern Pipe DIVISION OF U.S. INDUSTRIES, INC.
P.O. BOX C • AZUSA, CALIFORNIA • CUmberland 3-7111 – EDgewood 7-1221

Check ✓ PARSONS® Trenchliners for pipeliners

✓ 6 to 18 in. wide with little 77...

Here's another Parsons Trenchliner that will interest you — the small ladder-type 77. It's only 3 ft.-10 in. wide — and just 5 ft.-8 in. "low" (with boom in digging position). It produces up to 21 lineal ft. of trench per minute — 6 to 18 in. wide. Depths to 5 ft. A complete selection of larger Parsons ladder and wheel-type machines also available.

✓ Dig 20 TO 32 IN. WIDE with wide-wheel 170...

Developed to meet your needs for wide work range in a *medium-size* machine, Parsons 170 wheel-type Trenchliner® is large enough for mainline trenching — yet small enough to be used as an auxiliary unit for opening laterals and gathering lines. It produces from 12 inches to 25 lineal feet of trench per minute — 20 to 32 in. wide, at depths to 5¾ feet.

Hydraulic power raises and lowers the wheel on vertical mast with fractional-inch accuracy — and tilts the mast for traveling or trailer-loading. But that's not all — a hydraulic control system on the conveyor gives belt speeds up to 600 feet per minute — *completely independent of digging wheel speeds.* Belt easily handles maximum yardages from the extra-wide wheel — puts spoil bank well back beyond edge of trench. To handle a wide range of soil conditions, Parsons 170 has cast-steel buckets with self-sharpening, reversible "Tap-In" teeth — or quick-change gumbo buckets. Want more facts? Contact Parsons distributor, or send coupon.

Mail to: PARSONS Company, Newton, Iowa *A division of Koehring Company*

Send us literature on: ☐ 170 wheel-type ☐ 77 ladder-type Trenchliner

NAME ..... TITLE .....

COMPANY .....

STREET .....

CITY ..... STATE .....

P821 PI

Trench widths from 6 INCHES to 6 FEET... depths to 19 FEET

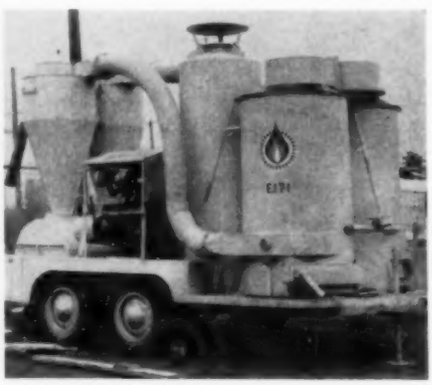
Gate Valve

Grove Valve & Regulator Co. has introduced a 36-inch high pressure gate valve which will permit an unrestricted flow at pressures up to 960 pounds per square inch.

When installed in a line, a heavy steel plate enclosed within the rectangular housing above the line opening will act as a cut-off gate if it is necessary to stop the flow. The gate is lowered and raised by a series of gears driven by an electric motor mounted on top of the 25,730-pound valve. Steel ribs on housing support valve when gate is lowered through high pressure flow. Ribs and gate are fabricated from Kaisaloy, high strength, low alloy steel manufactured by Kaiser Steel.

(This item supplements Grove Valve & Regulator Co. data on pages 213-224 of the Pipe Line Catalog, Second Revision.)

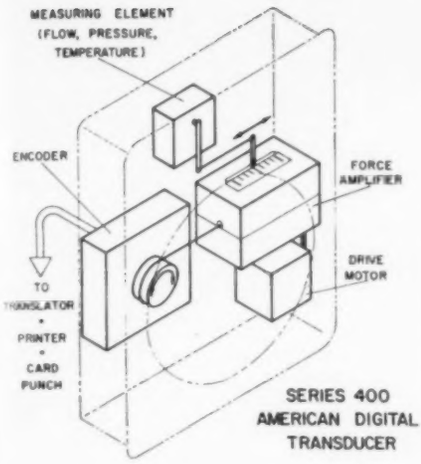
For more data, circle **No. E13** on Readers' Service Card, last page this issue.



Pipe Line Cleaner

Conveyair Inc., has introduced a "vacuum cleaner for gas lines" cleaning pipe up to 16 inches in diameter. Two models, powered by Hercules air-cooled 35 and 71 horsepower engines. In operation, the Conveyair cleaner is attached to one end of the pipe and a router is worked into the other. As the router scrapes along, removing all loose materials, the Conveyair unit sucks it into large built-in holding bins.

For more data, circle **No. E14** on Readers' Service Card, last page this issue.



SERIES 400
AMERICAN DIGITAL
TRANSDUCER

Digital Transducer

A digital transducer for measuring process variables and to provide digital encoding for flow, liquid level, pressure or temperature, has been developed by American Meter Company. The transducer employs the mechanical American force amplifier, actuated directly by standard measuring elements, to position the shaft of a precision encoder (analog to digital converter.)

The units are available in vacuum and pressure ranges to 10,000 psi, temperature ranges to 600°F and in mercury or bellows type manometers for liquid level or flow applications.

For more data, circle **No. E15** on Readers' Service Card, last page this issue.

Tractor Pipe Handler

Clark Equipment Company has developed a new tractor pipe handler, Model 175, and an exploration tractor, Model 75. The pipe handler has a hydraulically controlled clamp with a lifting capacity of 20,000 pounds. It is made up of 4-foot forks plus two individually operated clamps to trip the pipe. The 162-horsepower turbocharged diesel-powered machine offers powershift transmission with torque converter drive, power steering, all hydraulic controls, four wheel drive and four speeds forward and reverse to 27 mph.

The 110-hp exploration tractor was designed for pioneering work in rough areas where roads may be crude or non-existent. Powershift transmission with torque converter drive supplies power to all four driving wheels.

For more data, circle **No. E16** on Readers' Service Card, last page this issue.

Drilling with KA-MO . . .

6-in. bore under street —

Drilling 6-in. diameter hole, 40 ft. long under city street for gas line . . . this unit is powered by a 6 h.p. air motor using a standard double-track mounting. Ka-Mo drills are rugged, versatile . . . handle all materials from sand, clay, gumbo to frozen ground, shale, limerock . . . and other mineral formations.

24-in bore inside casing

Powered by an 18 h.p. air motor . . . Ka-Mo horizontal drill quickly bored 24-in. diameter hole inside casing, 106 ft. long through compacted clay and ballast under a railroad bed for new gas distribution line. *Actual drilling time . . . only 4 hours!* Casing and drill move forward at same time, protecting against costly cave-ins.

Whether your work involves angular, vertical or horizontal drilling, it will pay you to check the big Ka-Mo line. Drill sizes: 2 to 48-in. diameter, and larger . . . sectionalized lengths . . . air, hydraulic, electric, gasoline or diesel powered.

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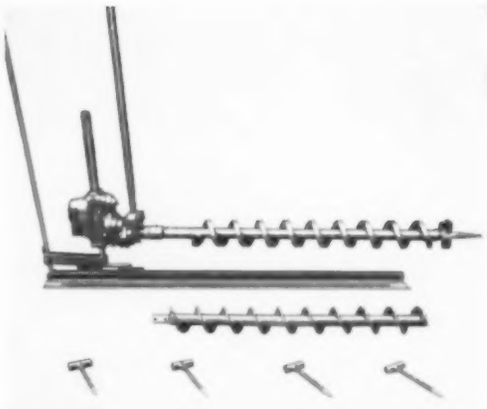

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Send free data on:
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☐ angular drilling equipment
☐ pipe anchor install. equip.
Dia. of hole ..... inches
Length of bore ..... feet
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KAM905 PL

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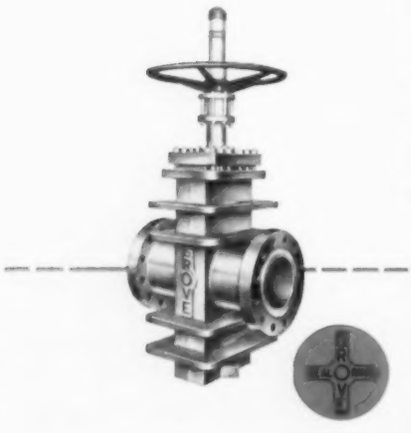

Here's the valve you set and forget. Grove's exclusive Seal-O-Rings wipe out the need for valve lubrication. You're never stuck with valve failure because of forgotten lubricant or depleted sealing compound. The load of lubrication is gone forever. Specify Grove Seal-O-Ring Gate Valves. Under pressure the tightest seal in the line.

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New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers' Index. Simply circle code numbers of items desired—sign and mail card.

Microwave Equipment

Describing its new "dual-beam" microwave equipment, General Electric has issued bulletin ECM 91.

The bulletin explains how the dual-beam concept offers additional protection against unpredictable communication failures by exceeding techniques usually found in automatic standby equipment. Cross-polarization of antennas makes continuous parallel operation of two sets of RF equipment possible, thus increasing reliability of the total system.

To get a copy, circle **No. E17** on Readers' Service Card, last page this issue.

Air Starting

To point up the growing trend toward cranking internal combustion engines with air power, Ingersoll-Rand has released a 24-page bulletin on air starting motors.

The bulletin contains case histories on air starting motor installations, gives information on how to select the proper air starting motor and lists advantages of these units. In addition, drawings show piping arrangements for each size and a suggested hook-up for using the motors on vehicles.

To get a copy, circle **No. E18** on Readers' Service Card, last page this issue.

Guaranteed Asphalt

Gulf States Asphalt Company has issued a four-page bulletin consisting of a guarantee on its No. 474 primer and No. 434 enamel coatings. The company guarantees that when the asphalts are applied properly, in accordance with good pipe line practice, they will render adequate and proper pipe protection for a minimum period of ten years. The four-page folder covers in detail the product and performance guarantee.

To get a copy, circle **No. E19** on Readers' Service Card, last page this issue.

Field Compressors

Clark Bros. Co. has issued a 48-page bulletin describing its HMB and TMB field compressor units and a 25-page bulletin on its CFA packaged field compressor.

Among the CFA features explained and illustrated are: balanced/opposed compressor for vibrationless performance; new positive direct drive; and unitized, vertical air flow radiator. Specifications are contained for complete line of two and four compressor cylinder models ranging from 100 to 350 bhp.

Complete details are given on the HBM and TBM compressors. Models are built in six sizes including three turbocharged models. Horsepower ranges from 330 to 660 bhp.

To get a copy, circle **No. E20** on Readers' Service Card, last page this issue.

Coated Plug Valves

An eight-page bulletin describing Rockwell-Nordstrom special coated lubricated plug valves has been published by Rockwell Manufacturing Company's meter and valve division.

Descriptions of the coating properties, valves available, tables of recommended applications and photo-illustrations, showing typical installations are included. The K-51 (Penton) is a new thermoplastic polymer that provides outstanding chemical resistance to both inorganic and organic agents. Kanigan coated valves are valves with a uniform, hard, corrosion resistant nickel alloy coating. Teflon coating is available on the plugs of standard pattern Rockwell-Nordstrom valves.

To get a copy, circle **No. E21** on Readers' Service Card, last page this issue.

Dresser Equipment Guide

Dresser Industries, Inc., has published its 1959 edition of Dresser Industries "World-Wide Guide to Dresser Equipment and Technical Services." The 68-page booklet is highly illustrated and provides references to many products and services supplied by Dresser and subsidiaries.

Convenient lists of Dresser representatives and their addresses in various countries are included.

To get a copy, circle **No. E22** on Readers' Service Card, last page this issue.

Oil-Immersed Contactor

Construction and design features of Allis-Chalmers unmounted oil-immersed ac contactors are described in a four-page bulletin. Designed for operation in hazardous, corrosive or dusty atmosphere, the unit is rated at 400 amp, 5 kv, 50 mva. It is designed to handle 2,500-hp squirrel cage motors at 4,800 volts and unity power synchronous motors up to 3,000 hp, 4,800 volts.

The unit is 20-inches deep, 29-inches wide, and 32-inches high over bushings. It weighs 270-pounds less oil and is equipped with an oil level sight gage drain and fill plugs.

To get a copy, circle **No. E23** on Readers' Service Card, last page this issue.

Big-Capacity Engines

Hercules Motors Corporation announces publication of a two-page bulletin describing its Hall-Scott series of big-capacity V-12 industrial power units.

The multi-fuel power units are designed for industrial applications where high horsepower with low engine weight is desired. The units developed 550-hp at 1,800 rpm, using butane or gasoline and 450-hp with natural gas. Total weight, including radiator and power take-off, is 6,700 pounds. Piston displacement is 2,180 cubic inches, bore, 5¾ inches, and stroke, 7 inches.

To get a copy, circle **No. E24** on Readers' Service Card, last page this issue.

HOT DOPE FROM MYOCO KETTLES

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Safety is assured, since fuel tank is installed inside of frame and protected from firebox by bulkhead.

The MYOCO asphalt kettle is available in 10, 27, 30 barrel sizes, powered by a Wisconsin engine or its electric equivalent, and with Athey tracks, steel skids, or fitted for stationary use. Blower or mailbox type burners are optional.

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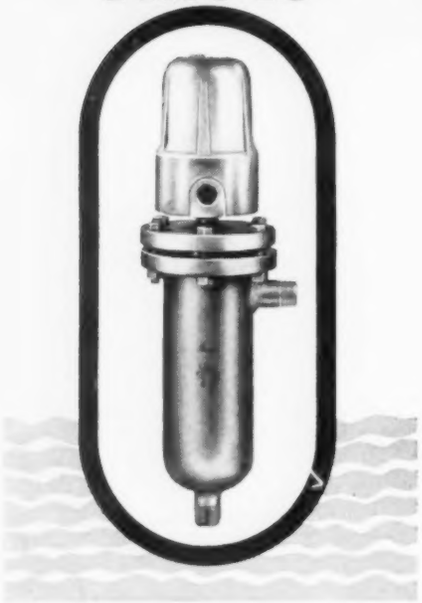

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CPS Undertakes Largest SINGLE PACKAGED Pipe Line Protection Job

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Houston Texas Gas and Oil Corporation selected CATHODIC PROTECTION SERVICE to design and install a complete cathodic protection system for their new natural gas pipeline. This line runs from Baton Rouge, Louisiana, to Miami, Florida, covering a distance of 1616 miles.

This is the largest *single packaged* pipeline cathodic protection job yet undertaken. CPS is in a unique position to handle just such a job . . . serving as a central source . . . for all phases of corrosion mitigation on any new pipeline.

The Maloney type-57 Insulator chosen for the Houston Texas Gas and Oil Corporation pipeline.

CPS has its own engineering crews who obtain the information necessary to complete the detailed design of a cathodic protection system. Plus this, CPS furnishes all materials, labor, equipment and engineering supervision to install cathodic protection on a *packaged* basis. Because it is a package, CPS can immediately follow the laying contractor, providing complete protection to the pipeline system soon after the last foot of pipe is laid. In addition to the cathodic protection package, CPS also serves as a central source of supply for other materials which were used on this pipeline, i.e., Polyken polyethylene tape, Maloney type 57 plastic casing insulators and the L & M pipeline markers, casing vents and test lead boxes.

Route of the Houston Texas Gas and Oil Corporation system.

The Polyken method that allowed the contractor to lay an average of better than 10,000' of 24" pipe a day.

This represents a package within a package which CPS can deliver: (1) L & M gas line marker (2) Gas vent with cover (3) Test lead box with lead wires.

We at CPS believe a strong relationship is essential among manufacturer, supplier and customer. We know through experience that ties of this sort mean more initial and repeat business. If you are considering a similar big pipeline job, why not talk it over with us and see how our *single packaged* cathodic protection can give you cost-cutting advantages. It will cost you nothing to find out.

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